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Executive Summary

This document describes the second version of the APOSDLE Integrated Modelling Methodology. This methodology, which updates the previous version described in Deliverable D1.3 (Integrated Modelling Methodology – First Version), guides the process of creation of the application domain dependent parts of the APOSDLE Knowledge Base. The APOSDLE Knowledge Base provides the basis for reasoning within the APOSDLE System.

Compared with this first version several changes were made both in the structure of the methodology and in the tools which are used to support it. These changes take into account the extensive feedback that was collected during the development of the first version of the Application Partner Domain Models, which were used in the APSODLE Prototype 2.

The second version of the methodology consists of four main phases, which cover the entire process of model creation, from the initial selection of the application domain to its final specification:

Phase 0. Scope & Boundaries. In this phase the scope and boundaries of the application domain are determined and documented. The first step of this phase is to use questionnaires and workshops to elicit the main tasks and learning needs of the different Application Partners in order to identify candidate application domains for learning (also called learning domains). The candidate application domains are then discussed, and the final domain is then chosen and briefly documented. Furthermore, resources which may be relevant for chosen learning domain are collected. The key aspect of this phase is to support the Application Partners to identify a learning domain which is appropriate for the "learn @ work" approach taken by APOSDLE.

Phase 1. Knowledge Acquisition. The goal of this phase is the acquisition of knowledge about the application domains that have to be formalised and integrated in the APOSDLE knowledge base. The proposed methodology aims to extract as much knowledge as possible from both Domain Experts and available digital resources identified by the Application Partners. The elicitation of knowledge from Domain Experts is based on well known state-of-the-art techniques like interviews, card sorting, laddering, and concept/step/chapter listing, while the extraction of knowledge from digital resources is based on algorithms and tools for term extraction described in (Pammer, Scheir, & Lindstaedt, 2007). The key aspect of this phase is twofold: first, the methodology has to support the effective and rapid knowledge acquisition from Domain Experts, who are often rarely available and scarcely motivated towards modelling; second the methodology has to ease the process of modelling by reusing knowledge already present in digital format in the organisation.

Phase 2. Modelling of Domain + Tasks. Starting from the knowledge elicited in Phase 1, in this phase a complete formal description of the domain and task models, which are part of the APOSDLE knowledge base, is provided: the domain model is about the specific work domain (application domain) a user wants to learn about with APOSDLE, while the task model concerns the activities and tasks a user can perform in the organisation. This description also contains a first alignment between domain elements and tasks, which is used in Phase 3 as a basis for creating the learning goals model, that is, the model describing the learning goals a user can have in the organisation inside the specific application domain. The model descriptions are created using the Modelling WiKi (MoKi), a tool developed within the project. The MoKi allows users to describe the elements of the different models in an informal but structured manner, using Natural Language. It automatically translates these structured descriptions in formal models, without requiring the Application Partners to become experts in the formal languages used to produce the formal models. The domain and task models created are then validated and possibly revised (in **Phase 2a. Validation & Revision of Domain + Tasks**); guidelines for manual revision and automatic validation checks are provided to support the Application Partners during the revision process.

Phase 3. Modelling of Learning Goals. In this phase, a formal specification of the learning goal model is produced. Starting from the initial alignment between domain elements and tasks

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produced in Phase 2, the users specify in details the learning goals using the Task And Competency Tool (TACT), a tool specifically developed within the project. The learning goal model created (and its connection to the domain and task models) is then validated and possibly revised (in **Phase 3a. Validation & Revision of Learning Goals**) according to the results of some automatic validation checks performed. At the end of this phase, the entire APOSDLE Knowledge Base is ready to be plugged into the APOSDLE system.

The second version of the Integrated Modelling Methodology has been accurately followed by each Application Partner to build their specific APOSDLE Knowledge Base. The specific models created are described in Deliverable D6.9 – Second Version of Application Partner Domain Models.

The feedback obtained from the experience of building the specific APOSDLE Knowledge Bases for the 3rd Prototype was used for a careful evaluation of the IMM – Second version, whose findings are reported in the final part of the deliverable.

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1 Introduction

1.1 Purpose of this document

This document describes the second version of the APOSDLE Integrated Modelling Methodology (IMM). This methodology, which updates the previous version described in Deliverable D1.3 Integrated Modelling Methodology – First Version, guides the process of creation of the application domain dependent parts of the APOSDLE Knowledge Base. The APOSDLE Knowledge Base provides the basis for reasoning within the APOSDLE System.

The Methodology has been accurately followed by each Application Partner to build their specific APOSDLE Knowledge Base. The specific models created are described in Deliverable D6.9 – Second Version of Application Partner Domain Models.

This document provides: an overview of the evolution from the IMM – First Version to the IMM – Second Version (Section 2), a detailed description of the current version of the Integrated Modelling Methodology, together with the tools that were developed to support the Application Partners in their modelling activities (Sections 3 and 4), and finally an evaluation of the Methodology and a comparison between the first and the second version (Section 5).

1.2 Scope of this document

This deliverable is an updated version of the previous one: D1.3 Integrated Modelling Methodology – First Version. Compared with this first version several changes are made both in the structure of the Methodology and in the tools which are used to support it. These changes take into account the extensive feedback that was collected during the development of the first version of the Application Partner Domain Models, which were used in the APOSDLE Prototype 2.

In this document we focus on a detailed overview of the current version of the Integrated Modelling Methodology and on the APOSDLE Modelling Tools which were developed to support it. In addition, a qualitative evaluation of the Methodology is described. This evaluation uses feedback obtained using the same questionnaire that was used for the evaluation of the Integrated Modelling Methodology – First Version. The use of similar questionnaires has allowed not only to collect feedback, but also to make possible a comparative analysis between the two versions of the IMM.

1.3 Related Documents

This deliverable is related to the following documents:

- APOSDLE Deliverable D1.3 - Integrated Modelling Methodology – First Version
- APOSDLE Deliverable D2.7 – Conceptual Framework & Architecture – Version 2;
- APOSDLE Deliverable D6.9 – Second Version of Application Partner Domain Models;
- APOSDLE Deliverable D4.5 – Software Architecture for 3rd APOSDLE Prototype;
- APOSDLE Deliverable D1.9 - 3rd Prototype APOSDLE – Work & Modelling Tools;
- APOSDLE Deliverable D2.8 & D3.5 - The APOSDLE Approach to Self-directed Work-integrated Learning.

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2 Integrated Modelling of Domain, Tasks and Learning Goals: A Collaborative and Integrated Approach

The APOSDLE approach to work-integrated learning is based on a general purpose domain independent learning platform, plus a largely domain specific APOSDLE knowledge base, whose coarse grained schema is illustrated in Figure 1. This knowledge base formalises key aspects of the environment in which users operate:

- the (business) domain in which they act;
- the tasks (activities) they may perform;
- the learning goals they may need to acquire;

It also formalises the inter-relationships between these elements as well as some specific Instructional Types, which are needed to define learning goals and classify learning material[1].

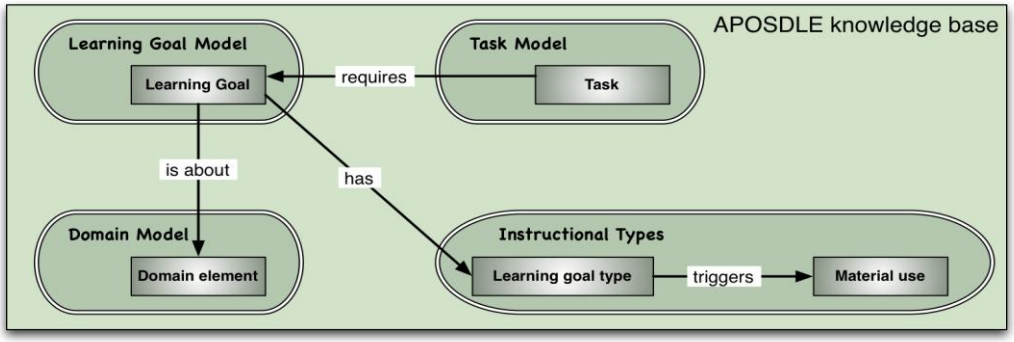

Figure 1 – The APOSDLE Knowledge Base

Building the domain specific part of the APSODLE knowledge base, namely the Domain Model, the Task Model, the Learning Goal model and their inter-relations requires several skills[2]. These skills span from *knowing* the different aspects that have to be described in the models, to having the ability of *encoding* such knowledge into formal statements, and to having the ability of *integrating* different aspects, such as the domain elements, the tasks and the learning goals into a uniform and coherent vision. For this reason, building the APSODLE knowledge base is inherently a collaborative activity, performed by different actors and carried out based on some collaborative protocol, which is usually described in the methodology used to support the modelling.

The Integrated Modelling Methodology (IMM) developed within the APOSDLE project, guides the process of creation of the application domain dependent parts of the APOSDLE Knowledge Base illustrated in Figure 1. For an overview of the initial reasons which motivated the development of an APSODLE Modelling Methodology we refer the reader to Deliverable D1.3 Integrated Modelling Methodology – First Version, where state of the art methodologies for Enterprise Modelling are presented and the motivations underlying the development of the IMM are discussed.

[1] A detailed description of the meta-model (schema) of the APOSDLE knowledge base is contained in Appendix 1.

[2] The domain specific parts of the APOSDLE knowledge base can be considered an example of enterprise model as described in (Fox & Grüninger, 1998).

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2.1 The IMM – First Version

The First Version of the Integrated Modelling Methodology, presented in Deliverable D1.3 Integrated Modelling Methodology – First Version, and briefly summarised in Figure 2, was built around a strict waterfall paradigm. In this paradigm the starting point of the modelling activities is a collection of informal knowledge provided by knowledge experts; this knowledge is transformed by knowledge engineers into a set of formal statements (possibly with the support of semi-automatic transformation tools), which constitute the final model. Evaluation steps are also planned at specific stages of the process.

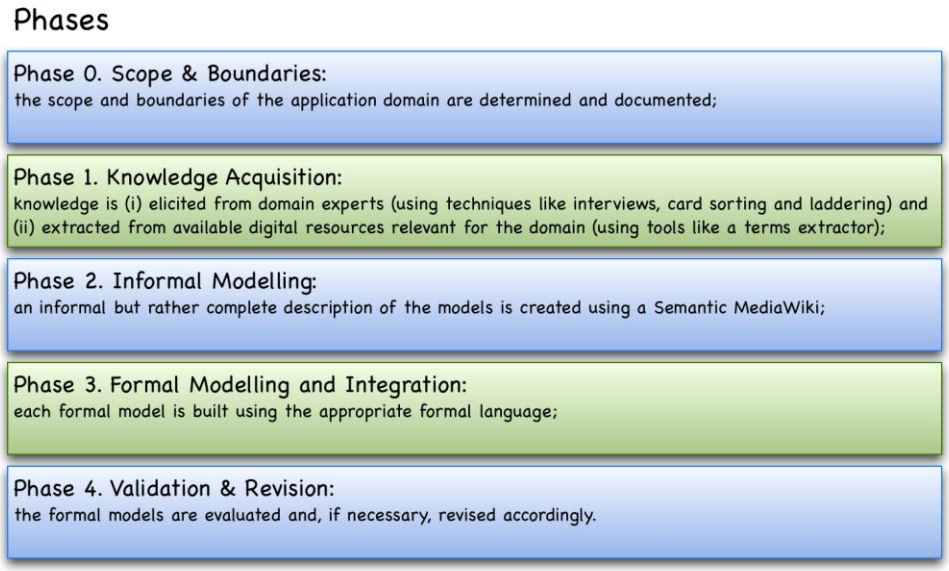
Phases
Phase 0. Scope & Boundaries:
the scope and boundaries of the application domain are determined and documented;
Phase 1. Knowledge Acquisition:
knowledge is (i) elicited from domain experts (using techniques like interviews, card sorting and laddering) and (ii) extracted from available digital resources relevant for the domain (using tools like a terms extractor);
Phase 2. Informal Modelling:
an informal but rather complete description of the models is created using a Semantic MediaWiki;
Phase 3. Formal Modelling and Integration:
each formal model is built using the appropriate formal language;
Phase 4. Validation & Revision:
the formal models are evaluated and, if necessary, revised accordingly.

Figure 2 – The IMM - First Version

The IMM – First Version also defines the actors who belong to the, so-called, "modelling team" and collaboratively work in the modelling process:

- **Domain Expert** (DE): The DE provides the fundamental knowledge about the domain of the users of APOSDLE and their learning needs. The DE also specifies the pool of resources to be used for knowledge extraction.
- **Knowledge Engineer** (KE): The KE helps the elicitation of knowledge from the DE and guides the entire modelling process.
- **Coach**: The coach is a person who comes from the APOSDLE team and has the task of supporting Knowledge Engineers, who are not completely skilled in modelling, throughout the entire modelling process.

The IMM – First Version was used by each Application Partner to build the specific APOSDLE Knowledge Bases for the APOSDLE 2nd Prototype (see Deliverable D6.8 – Application Partner Domain Models). From this experience, and from the evaluation of the feedback collected and reported in Deliverable D1.3 Integrated Modelling Methodology – First Version, several issues were identified and analysed. We repeat below the main issues as stated in D 1.3:

- **Identification of appropriate learning domains**. Guidelines and examples about what is an adequate learning domain/scenario for APOSDLE are missing. (Source: APs and Coaches)
- **Granularity of models**. Guidelines for and examples of the granularity of the models are missing. Therefore it is difficult to understand the "right" granularity at which to perform modelling. (Source: Aps)

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- **Workload of modelling**. Too much workload/effort is required to follow the methodology and perform modelling. Furthermore, an estimate of the workload/effort for each phase is missing. (Source: APs)
- **Importance of Knowledge Engineers.** The quality of the models created is much better when the APs can dedicate one or more persons to modelling activities. (Source: Coaches)
- **Importance of coaches.** The role of the coach is really important in the methodology. Good support from coaches was fundamental to achieve good modelling results (Source: APs and Coaches).
- **Importance of tools**. There is a close relation between the quality of the models created and familiarity with, or a good understanding of, the tools used, in particular of the Semantic MediaWiki. (Source: Coaches)

Another important factor that emerged from an analysis of modelling activities of the 2nd Prototype, and from an in depth evaluation of the way APOSDLE uses the data contained in the APOSDLE knowledge base, concerned the modelling of tasks. In the 2nd prototype tasks were modelled with the workflow based language YAWL. From the analysis of the experience of last year the following issues emerged:

- **Usability of the YAWL editor**: The usability of the YAWL tool was rated poorly by the application partners. Reasons were: the complex graphical interface and the long training needed to use the YAWL editor by domain experts with no knowledge engineering skills. YAWL is a language whose main function is to model business processes. Processes in the E-learning area appear to be much more informal than those in the business sector. Parallelism and jumps can only be cumbersomely constructed in YAWL and since these unusual constructs occur frequently in the domains of our application partners, they result in increased modelling effort and difficult to read models.
- **Over-expressive power of workflows**: The task models, as considered in APOSDLE, are not comparable with ordinary business models. First, the models are created mainly by domain experts with few modelling experiences and skills and they have to be kept simple. Second, and more important, the APOSDLE system does not use the expressive temporal information contained in workflows, but only needs to store simple information such as the task – sub-task hierarchy and some simple before-after relation between tasks. Thus, the workflow constructs of YAWL seemed to be over-expressive for the purpose of APOSDLE.

From an analysis of the issues reported above, as well as from the analysis of specific the feedback items reported in D1.3, we identified several requirements for a revision of the IMM:

- **A more integrated modelling process**. Most of the granularity issues reported by the Application Partners were in fact due to granularity mismatches between the Domain and the Task model. Thus, supporting the concurrent and inter-related modelling of these two modules of the APOSDLE knowledge base was deemed to be a necessary strategy to handle granularity issues[3].
- **A more agile modelling process**. This serves to reduce the workload of modelling and to strengthen an active collaboration between the members of the "modelling team". Several complaints concerned the fact that the iteration between informal and formal was too time consuming for the APOSDLE modelling activities. Thus, we decided to move away from a strongly structured waterfall paradigm and switch to a more agile collaborative paradigm illustrated in Section 2.2.
- **Simplification of the modelling of tasks**. The need of keeping the modelling process as simple as possible together with issues about the usage of the YAWL editor and the over-expressivity of YAWL, triggered a revision and a simplification of the way tasks are modelled

[3] Note that the granularity of models is a typical problem of modelling for which there is no general solution. We do not aim here at solving the problem in a general setting, but to handle this problem in the specific APOSDLE context.

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in APOSDLE. The YAWL language was dismissed in favour of the same ontology language (OWL) which is used to describe the other parts of the APOSDLE knowledge base[4]. The migration from YAWL to OWL also reduced the number of modelling tools. In fact, we decided to use one single tool (MoKi) to cover both the modelling of domain and tasks with a uniform interface and modelling style. This intends to strengthen the integrated modelling of domain and tasks and to reduce the training needed to use the modelling tools.

- **Better modelling tools.** This means to reduce the workload of modelling, to support the more agile modelling process envisaged for the IMM – Second Version, and to increase the quality and integration of models.
- **Better manuals / guidelines**. This intends to help the identification of appropriate learning domains, reduce the workload of modelling, increase the quality of models and also to support the specific contributions and roles required by the different actors inside the modelling team. Thus we decided to (i) improve the questionnaires used to support the identification of appropriate learning domains and (ii) write guidelines and manuals about the different phases and tools of the IMM to support coaches and domain experts in their modelling activities. Questionnaires, Manuals and Guidelines are contained in the Annex, at the end of the document.

2.2 The vision for the IMM – Second Version

The construction of the APOSDLE knowledge base is inherently a collaborative activity, performed by different actors (the so-called modelling team composed of domain experts, coaches and knowledge engineers) each with different know-how, technical skills and roles.

To support collaboration between the modelling team, and to allow greater flexibility during the cooperative modelling activity, we developed the collaborative modelling paradigm illustrated in Figure 3.

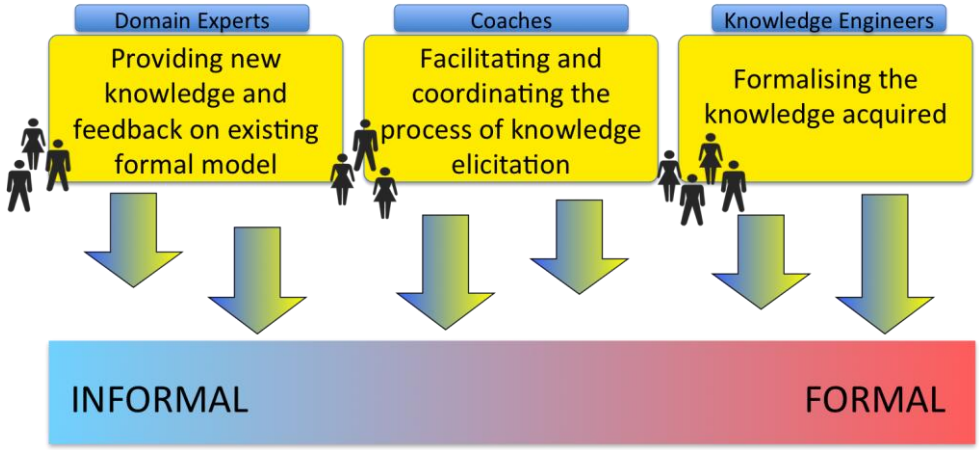

Figure 3 – The IMM Collaborative Approach

This paradigm is inspired by recent Web 2.0 collaborative solutions, of which wikis are one example, and was proposed in (Christl et al., 2008) and (Rospocher et al., 2008) as a way to support modelling activities in an enterprise modelling setting. In this paradigm all the actors asynchronously collaborate toward the creation of the APOSDLE knowledge base by inserting knowledge (either formal or informal), by transforming knowledge (from informal to formal) and by revising knowledge. The domain experts enter the missing knowledge - using a form of informal language - into the models or provide

[4] A detailed description of the current task model and of the reasons behind its simplification can be found in Appendix 1.

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feedback on the formal models created. Asynchronously, the knowledge engineers can refine the formal model by inserting new elements, by modifying existing knowledge or by asking for clarification from the domain experts. The usage of a robust collaborative technology, as the one provided by the wiki, allows the provision of state of the art functionality like simultaneous access and online communication via the platform.

To support these different actors we have proposed a system in which content can be represented at different degrees of formality. This, to enable domain experts to create, review and modify models at a rather informal/human intelligible level, and to allow knowledge engineers to check the quality of the formal definitions and their correspondence with the informal parts they intend to represent. In order to make this vision possible, without increasing the overhead of human work necessary to cope with these different representations of knowledge, the system must be able to maintain the alignment between the informal specification of the APOSDLE knowledge base and its formal version, and should also make the translation between different levels of formality in an automated manner as smooth as possible. This automatic alignment simplifies and makes more agile the interaction between the different actors of the modelling team, as it removes the need of having to stick to rigid interaction protocols centred around the informal vs. formal waterfall paradigm. In addition, this vision allows the actors of the modelling team to concentrate on *what* knowledge they are modelling (e.g. the business domain, the activities, the learning goals) rather than concentrating on the language in which the knowledge is specified. The choice of focusing on the *what* (or, in other words around the intention of "*having to think the same thing only once*") has enabled us to restructure the IMM around the parts of the knowledge base to be constructed, and their inter-relations, as depicted in Figure 4.

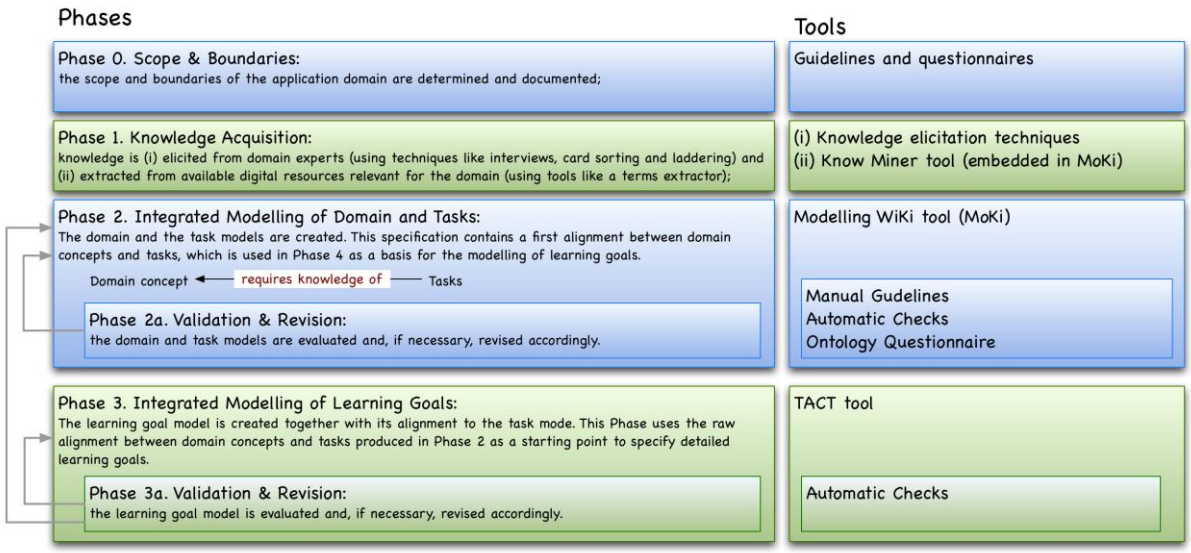
Phases
Tools
Phase 0. Scope & Boundaries:
the scope and boundaries of the application domain are determined and documented;
Guidelines and questionnaires
Phase 1. Knowledge Acquisition:
knowledge is (i) elicited from domain experts (using techniques like interviews, card sorting and laddering) and (ii) extracted from available digital resources relevant for the domain (using tools like a terms extractor);
(i) Knowledge elicitation techniques
(ii) Know Miner tool (embedded in MoKi)
Phase 2. Integrated Modelling of Domain and Tasks:
The domain and the task models are created. This specification contains a first alignment between domain concepts and tasks, which is used in Phase 4 as a basis for the modelling of learning goals.
Domain concept
requires knowledge of
Tasks
Phase 2a. Validation & Revision:
the domain and task models are evaluated and, if necessary, revised accordingly.
Modelling WiKi tool (MoKi)
Manual Gudelines
Automatic Checks
Ontology Questionnaire
Phase 3. Integrated Modelling of Learning Goals:
The learning goal model is created together with its alignment to the task mode. This Phase uses the raw alignment between domain concepts and tasks produced in Phase 2 as a starting point to specify detailed learning goals.
Phase 3a. Validation & Revision:
the learning goal model is evaluated and, if necessary, revised accordingly.
TACT tool
Automatic Checks

Figure 4 – The IMM - Second Version

As can be seen from Figure 4, this restructuring also supports, better than the steps of the IMM - First Version, the need for a coherent and integrated development of the different components of the APOSDLE knowledge base as it also focuses on the relation between the different models that have to be specified. In addition, it allows the provision of immediate and comprehensive feedback to the modellers, thus increasing the effectiveness of the modelling activities.

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The work performed during the third year of the APOSDLE project has been focused around the refinement and implementation of the IMM - Second Version and on a set of tools and the methodological support, which realise the collaborative integrated approach depicted in Figure 3. While the realisation of this full vision was not attainable within a single year, the current version of the IMM and of the suite of Modelling Tools provide a first concrete step towards its implementation, as it supports:

1. the access to the APOSDLE knowledge base at different levels of formality;
2. the integrated modelling of several aspects of the APOSDLE knowledge base; and
3. the coherent development of the formal part.

In Section 3 we illustrate in detail the different phases of the IMM - Second Version, while Section 4 focuses on the description of the Modelling Tools.

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3 The Integrated Modelling Methodology

3.1 Overview of the Integrated Modelling Methodology

The Integrated Modelling Methodology – Second Version consists of four phases, as depicted in Figure 4:

- **Phase 0. Scope & Boundaries.** The scope and boundaries of the application domain are determined and documented; questionnaires and workshops are used to elicit the main tasks and learning needs in order to identify candidate application domains for learning;
- **Phase 1. Knowledge Acquisition**. Knowledge is elicited from domain experts and extracted from available digital resources relevant for the chosen domain. Knowledge elicitation techniques (such as interviews, card sorting and laddering) are used to support knowledge elicitation from experts, while a terms extractor tool is used to support knowledge elicitation from digital resources;
- **Phase 2. Modelling of Domain + Tasks**. A specification of the domain and the task models is created. This specification also contains a first alignment between domain elements and tasks, which is used in Phase 4 as a basis for the modelling of learning goals. The specification is provided using the Modelling WiKi (MoKi) tool;
    - **Phase 2a. Validation & Revision of Domain + Tasks**. The domain and task models are validated and, if needed, revised. Guidelines for manual revision and validation checks are provided to help with the revision process.
- **Phase 3. Modelling of Learning Goals**. A specification of the learning goal model is created. This Phase refines the initial alignment between domain elements and tasks produced in Phase 2 to specify detailed learning goals. The specification is provided by using the TACT tool;
    - **Phase 3a. Validation & Revision of Learning Goals**. The learning goal model is evaluated and, if needed, revised. Validation checks are provided to help with the revision process.

Phases 0—3 are performed in a sequential manner. Revision loops can originate from Phase 2a and Phase 3a as shown by the arrows in Figure 4.

Main roles. The roles used in the Integrated Modelling Methodology - Second Version did not change compared with the ones described in the first version and reported in Section 2.1. The “modelling team” is therefore composed of Domain Experts (DEs), Coaches, and Knowledge Engineers (KEs).

3.1.1 The Knowledge Bases of the 3rd Prototype

We briefly summarise the five application domains chosen by the four Application Partners to be part of the APOSDLE 3rd Prototype. A full description of these domains and the models produced can be found in Deliverable D6.9 – Second Version of Application Domain Models. We also provide an overview of the team who performed the modelling for each Application Partner:

- CCI has changed its application domain after the evaluation of the APOSDLE second prototype. The new domain is about Information and Consulting on Industrial Property Rights. The modelling task was done by domain experts and by knowledge engineers from CCI, plus coaches from SAP.
- CNM has chosen two application domains for the APOSDLE third prototype. One of them is the RESCUE domain, a methodology for Requirement Engineering developed by City University, and was already used by CNM for the ASPOSDLE second prototype. In addition,

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CNM decided to add a new domain about the Information Technology Infrastructure Library (ITIL V3). The modelling task was done by domain experts and by knowledge engineers from CNM, plus coaches from SAP.

- EADS IW decided to keep and elaborate the domain chosen for P2, the Simulation Domain, focusing for P3 on the electromagnetism physical domain. The modelling task was done by domain experts and by knowledge engineers from EADS, plus coaches from FBK.
- ISN has chosen a new domain on Innovation management in a network of SME´s with boundaries on "Consulting, project management and further education in the field of innovation management". The modelling task was done by domain experts and by knowledge engineers from ISN, plus coaches from KC.

In addition FBK provided an additional knowledge engineer to supervise the entire modelling process for all the Application Domains.

3.2 Phase 0. Scope & Boundaries

3.2.1 Goal

In this initial step of the methodology, the goal is to define the scope and boundaries of the respective application domains and to identify potential learning resources. The desired output of Phase 0 is threefold: A first, preliminary list of tasks (called process scribbles) roughly specifies the tasks that have to be performed by workers in the application domain. Further, a first list of learning goals describes abilities, skills, and knowledge that should be present in people performing these tasks. Moreover, a collection of representative documents should indicate relevant learning resources. Scope & Boundaries for the domain that are identified in this modelling phase have to be documented in an appropriate manner. In P2 for instance, the results were verbally described in a central wiki whereas in P3 previously existing models plus short statements about intended changes / additions served as documentation.

3.2.2 Description

At the beginning, an initial questionnaire about target groups, target tasks, and learning needs of the application domain was filled in by the KE in cooperation with the involved parties in the company (DEs, future learners, decision-makers in the company). Since most of the knowledge engineers and some of the domains were the same as in P2, the subsequent steps of Phase 0, as followed for P2 were not carried out. In principle however, Phase 0 is still intended to contain a **workshop**, in which the KEs are informed about the procedure of modelling (this methodology) and the roles of models in APOSDLE. By means of concrete, written scenarios, tasks shall be identified and concrete learning needs derived. Simultaneously, **resources should be collected** that constitute potential learning materials.

3.2.3 Supporting Tools, Techniques & Resources

3.2.3.1 Initial questionnaire

As mentioned above, an initial questionnaire was used to gain insight about properties of the application domain. The questions identified target user groups and their tasks, the application domain, typical learning needs and high level learning goals (central domain concepts). The questions also asked about existing learning support and perceived insufficiencies, e.g. bottlenecks experienced during learning from experts, as well as existing digital resources containing knowledge about the application domain. On the one hand, its purpose is to ascertain the suitability of the learning domain for APOSDLE and the support of the company for the introduction of a work-integrated learning system such as APOSDLE. For instance, if only a very few knowledge workers will benefit, and

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personnel turnover is very low in a company, it is questionable whether APOSDLE is suitable for this company. On the other hand, its purpose is to document the intended learning domain, the target user group, the tasks of the intended APOSDLE users etc.

The theoretical foundation of this questionnaire is detailed in the APOSDLE Deliverable 2.8, & 3.5 (2009), and the questionnaire itself is appended in the Annex (Part 1: Initial questionnaire (Scope & Boundaries)). The questionnaire is designed in such a way that it can be either filled out remotely, or be used as a guideline for a personal, structured interview. The questionnaire is accompanied by interpretation guidelines, such that any person who is reasonably acquainted with APOSDLE can provide advice about the suitability of APOSDLE. This questionnaire was given to all application partners for P3, filled out and interpreted by the coaches together with the knowledge engineers.

3.3 Phase 1. Knowledge Acquisition

3.3.1 Goal

The goal of the Knowledge Acquisition step is to extract as much knowledge as possible from both, digital resources provided by the DEs, and by eliciting knowledge directly from the DEs. The results are a refined task list and an extensive list of candidate domain concepts that are documented in the modelling wiki.

3.3.2 Description

Phase 1 is subdivided into two different activities, namely “Knowledge Acquisition from Digital Sources”, and “Knowledge Elicitation from Domain Experts”. The two activities are running in parallel.

3.3.2.1 Knowledge Acquisition from Digital Sources

The KE uses text mining services such as relevant term extraction and document clustering to automatically elicit relevant topics from the digital resources collected in Phase 0.

The available text mining functionalities are analogous to the functionality of the Discovery Tab Protégé plug in described in (Pammer, Scheir, & Lindstaedt, 2007). The text mining functionalities support the English and the German language. The functionalities are: (i) extract relevant terms from a set of documents, (ii) group synonymous terms, (iii) cluster a set of documents and (iv) extract relevant terms of each cluster.

The text mining functionalities were embedded in the MoKi[5] (see Section 4.2.2.1). This means, that knowledge acquisition immediately delivers an input to modelling, since extracted terms can directly be “saved” as potential concepts if the KE deems them to be relevant.

3.3.2.2 Knowledge Elicitation from Domain Experts

In order to elicit knowledge from the DEs, the KE applied various techniques. Structured interviews were conducted by the KE for refining the list of domain concepts, the list of tasks, the relations between tasks and the mappings between tasks and domain concepts. Special knowledge elicitation methods (e.g., card sorting, laddering, step listing, chapter listing) were applied for eliciting tacit knowledge from the DEs. *Concept listing*, *step listing* and *chapter listing* were suggested by Cooke & McDonald (1986). The original procedure of *card sorting* was described, for example, by Maiden & Rugg (1996). We have slightly adapted it for our methodology. Of course, not all knowledge elicitation techniques have to be applied in every domain. Choosing knowledge elicitation techniques depends on the requirements of the respective model. For instance, if already many concepts have been brainstormed for the domain, *concept listing* does not need to be applied.

[5] MoKi: the wiki which supports Phase 2, for a full description see Section 4.2.

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3.3.3 Supporting Tools, Techniques & Resources

Here we briefly describe the techniques we propose in our IMM to support the Knowledge Acquisition phase. Below we present the techniques for Knowledge Elicitation from Domain Experts, while an extensive description of the text mining functionality supporting Knowledge Acquisition from Digital Sources is provided in Section 4.2.2.1.

3.3.3.1 Structured Interviews

Based on the first-cut task list and process scribble that was generated in Phase 0, a more fine-grained task list should be generated, and further relevant domain concepts should be identified. Therefore, the KE conducted structured interviews with the DE. Tasks were broken down into sub-tasks by asking for each task in the first-cut task list, what were its subtasks. This was performed, until the KE and DE were able to obtain the desired granularity of the task list. Whether the task list is fine-grained enough depends on the intended use of the learning environment and on the intended target group, and the decision has to be made by the knowledge engineer. As a rough guideline, the task should require a manageable amount of learning goals that can be acquired in a reasonable time by the intended target group during work-integrated learning. However, defining objective criteria for the ideal degree of granularity of the task list is still an open issue, and is one of our research questions in future work.

Relations between tasks were identified by asking for each task and each sub-task, what input would be required, and what the output was. Relevant domain concepts and learning goals for a task or a sub-task should be elicited by asking for each task, what knowledge was needed for accomplishing the task, and for guidelines on performing the task.

3.3.3.2 Concept Listing

Concept listing is a simple interview technique in the course of which the expert is asked to answer the question “What topics does a person has to have knowledge about, in order to do X?”. For instance, in APOSDLE, the question could be “What topics does a person has to have knowledge about in order to make a simulation of the effects of lightening on an airplane?”. Unlike Cooke & McDonald (1986), who asked the respondents to write down all the concepts on a sheet of paper, we were logging the interviewee’s oral responses. That way the interviewee can concentrate on brainstorming concepts and can speak them out immediately without having to write them down and more concepts can be listed. The outcome of concept listing is an unstructured list of concepts relevant for the domain. Depending on the size of the domain, concept listing takes approximately 10-15 minutes.

3.3.3.3 Step Listing

Step listing is very similar to concept listing, with the difference that the expert is asked to list all the steps in the process of doing X, without worrying about their sequence. The question that is asked to the respondent is “What are the specific steps that a person has to do for performing X?”. An APOSDLE example for this question would be “What are the specific steps that a person has to do for performing innovation management?”. The outcome of step listing is a possibly unstructured list of tasks that have to be performed by a person in the learning domain. Depending on the domain, step listing takes approximately 10-15 minutes.

3.3.3.4 Chapter Listing

In chapter listing, the expert is asked to imagine that he or she wanted to write a book about the domain under consideration. The expert then is told to come up with proposed chapter titles and subtitles for such a book. For instance, the question for an APOSDLE domain could be “If you would write a book about requirements engineering, what would be the chapters and sub-chapters?”. The outcome of chapter listing are mainly concepts, which, unlike in concept listing, already have some structure. Depending on the domain, chapter listing takes approximately 30-45 minutes.

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3.3.3.5 Card Sorting

Card sorting is a technique that is very often applied in information design processes in order to generate an overall structure for information, as well as suggestions for navigation, menus, and possible taxonomies. In Phase 1 of the modelling methodology, it was performed with the DEs to find relations between domain concepts, and for identifying new relevant domain concepts. Card sorting is a quick, inexpensive, and reliable method that can provide insight to the DE's view of the domain and that can make tacit knowledge explicit. Card sorting was applied for two different purposes in the process:

I. For eliciting expert knowledge with respect to the structure of tasks and concepts

II. For eliciting expert knowledge with respect to the knowledge required for each task

For eliciting expert knowledge with respect to the structure of tasks and concepts (sub-concept hierarchies, sub-task hierarchies), card sorting is performed as follows. The KE, with the help of coaches if applicable, prepares a set of cards (objects) with a clear description for each one of them. This set of objects could be a set of resources or a set of previously chosen domain/task concepts. The KE shuffles the cards and gives them to the DEs, asking the DEs to sort the cards in different groups or piles. The KE then asks the DEs to specify the criterion used to sort the cards into these groups. Better results can be usually obtained by small groups of DEs working together. The KE documents the piles obtained and the sorting criterion applied by the DEs. Next, the KE shuffles the cards again and gives them back to the DEs asking for a new sort according to a different criterion. Sorting with the same set of cards should proceed as long as the DEs are still able to come up with different sorting criteria. Card sorting takes approximately 10-15 minutes per sorting trial. Typically, DEs are able to sort objects according to 8-10 criteria.

For eliciting expert knowledge with respect to knowledge required for each task, a (preliminary) list of tasks and topics already has to be modelled. In preparation of the card sorting session, one card is prepared for each of the tasks and the topics. Cards for tasks must have different colours than cards for topics. For the sort, better results can be usually obtained by small groups of DEs working together, because biases in a single expert's view of the domain can be identified more easily. The procedure is similar to the one described above, except that one task of interest is selected and the respective card is laid on the table in front of the two experts. The experts are asked to describe what is meant by the task, what are the input and output of the task (i.e. what does one "have" when starting the task, what does one "produce" when the task is finished). Next, the DEs are asked to pick topics, which are relevant for the task and to start to find a common solution, i.e. a common agreement on the set of topics which are required for the task. Typically, this leads to discussions among the experts which can also serve as valuable source of information for the knowledge engineer. For instance, often, experts arrive at conditions under which one set of topics is required for a task, and conditions under which another set of topics would be more helpful. From such discussions, tasks can be identified which are too broad, or too generic, etc. Once the experts arrive at a conclusion, the result is documented (e.g. photographed). This procedure is repeated for all tasks of interest. For each task, the procedure leads to a preliminary task-topic assignment. Other possible outcomes (side-products) of the card sort are tasks that need to be renamed, tasks that are unnecessary, a wrong task sequence of tasks, missing tasks and concepts need to be refined or to be defined.

During 2 hours, approximately 10 tasks can be worked on. It is important to pre-select tasks that shall be discussed during the session and to pre-select the cards for these tasks from the list, in order to warrant a smooth process. Walking through the tasks in a "regular" sequence (i.e. in the sequence in which they are usually performed) works better than doing it in a random sequence. The latter type of card sorting is a very interactive technique with quite some "action". According to the feedback of DEs, it is even sometimes "funny" (as far as KE can be funny), due to the ludic and interactive character of the method.

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3.3.3.6 Laddering

Laddering is a semi-structured interview technique that is employed in order to break-down and refine identified domain concepts or to detect relationships between concepts. The KE starts from one domain concept, for example, the high level concept “Method”. For instance, the question “Which methods do exist?” leads to a number of domain concepts, for instance, “Brainstorming Techniques”, or “Knowledge Management Techniques” that are connected to the starting concept by a relation of type “is-a”. This procedure is then repeated for the new concept, for example, by asking “Which Knowledge Management Techniques do exist?”, and also for the resulting domain concepts until the desired degree of granularity is obtained. In so doing, a “cognitive ladder” between different domain concepts is established. As for the granularity of the task list, the decision about the granularity of domain concepts is on the knowledge engineer. For taking this decision, several factors, such as the resources available, but also the documents to be created in the future or the potential learning goals for workers have to be taken into account. Depending on the desired granularity of the model and on the granularity of the “starting concept”, laddering takes approximately 10-15 minutes per concept.

3.4 Phase 2. Modelling of domain + tasks

3.4.1 Goal

Starting from the knowledge elicited in Phase 1 (see Section 3.3), the main goal of this step is to create a specification of the domain and the task models. This specification – which also contains a first alignment between domain elements and tasks used in Phase 3 (see Section 3.6) as a basis for the modelling of learning goals – is created using MoKi (see Section 4.2) the tool we have developed within the APOSDLE project to support this specific phase of the IMM.

3.4.2 Description

The goal of Phase 1 was to acquire as much information as possible. During Phase 2, the KEs have to process this information, in order to produce a complete description of the application domain and of the tasks a user can perform. A set of guidelines is provided to support the KEs in processing the list of candidate domain concepts and tasks. (see Sections 3.4.3.1 and 3.4.3.2).

Once the list of concepts and tasks composing the models has been created, the KEs start creating the domain and task model with MoKi, the tool based on Semantic MediaWiki we have developed to support the modelling activities in this phase of the IMM. For each domain concept and tasks, a page in MoKi is created, and for each of these, the user is asked to fill some templates using predefined forms. Although the KEs provide the descriptions of the elements of the task and domain model in Natural Language, since these descriptions are structured according to pre-defined templates (with the help of semantic constructs like properties), they contain sufficient structure to be automatically translated in formal models (OWL ontologies in the case of the APOSDLE KB). Thus, the KEs do not need to become experts in formal languages to create the domain and task models: they just need to fill the templates (one for each task, and one for each concept) via forms.

Note: to enable the compact modelling of similar tasks, a mechanism of task parametrization was introduced in the IMM – Second Version. A detailed description of this mechanism is contained in Appendix 1 (Section 7.2.2). The main idea is to add a parameter (also called variable) from the domain model in the name of a task in order to use the knowledge present in the domain model to specify families of tasks in a compact manner, to reduce modelling effort.

At the end of this phase, MoKi contains a set of filled templates (one for each task and one for each domain concept), which are then automatically translated by the MoKi’s OWL-export functionality in an OWL domain model and an OWL task model.

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3.4.3 Supporting Tools, Techniques & Resources

To support this phase of the methodology, we developed:

- A set of guidelines to filter from the concepts and tasks acquired in Phase 1 of the Methodology those which will be included into the domain and task models.
- A tool called MoKi (**Mo**delling Wi**Ki**), based on Semantic MediaWiki (see Section 4.2 for a detailed description of the tool and of the reasons which motivated our choice of developing it on top of Semantic MediaWiki), which supports the activity of creating the domain and task models.
- A manual of MoKi, attached in the Annex (Part 2: Moki User Manual), which contains some modelling guidelines and a technical description of how to use MoKi, and which is distributed to all the actors involved in the modelling activities.

Below we briefly present the guidelines provided to choose the relevant domain concepts and tasks, and we describe the templates the KEs has to fill to create the formal domain and task models.

3.4.3.1 Guildelines for choosing relevant domain concepts

Starting from all possibly relevant terms generated in Phase 1, the KE decides which ones are relevant domain concepts and which ones should be discarded and prepares a list to be validated by the DEs. To help deciding about relevant concepts in the APOSDLE knowledge base, the following guidelines were given:

1. Is this domain concept useful for retrieval?
   1.1. Are there resources dealing with this domain concept, or is it reasonable to expect resources dealing with this domain concept in the future?
   1.2. Does this domain concept help to differentiate between resources?
2. Does this domain concept refer to a learning goal of a hypothetical APOSDLE user?
   2.1. Does this concept help APOSDLE to support the mastering of the learning goal?

As a general rule, it is suggested to keep possibly “irrelevant“ concepts, rather than risking to remove relevant ones. Nevertheless, it is clear that the consequence of keeping irrelevant information at this stage increases the effort of modelling in every subsequent modelling stage.

3.4.3.2 Guidelines for choosing relevant task

Starting from all possibly relevant tasks generated Phase 1, the KE decides which ones are relevant tasks and which ones should be discarded. To help deciding about relevant tasks in the APOSDLE knowledge base, the following guidelines were given:

1. Does the task refer to a situation / task in which learning supported by APOSDLE shall occur?
   1.1. Does the task require knowledge that lies inside the specified learning domain?
   1.2. Should APOSDLE be able to support this task?
2. Is the task recognisable for the future APOSDLE user?

The statement “I am currently doing task X” should make sense to the future APOSDLE user and should provide a good insight in the correct granularity level of a task. For instance, the statement “I am currently performing an activity” would be too generic, and it probably would not make sense to a user, while the statement “I’m currently pressing the -ESC- character” would probably be too specific and in most cases would not make sense for a user to be recognized as a separate task .

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3.4.3.3 Domain concept Template

Figure 5 shows a screenshot of a filled form associated to a domain concept template in MoKi.

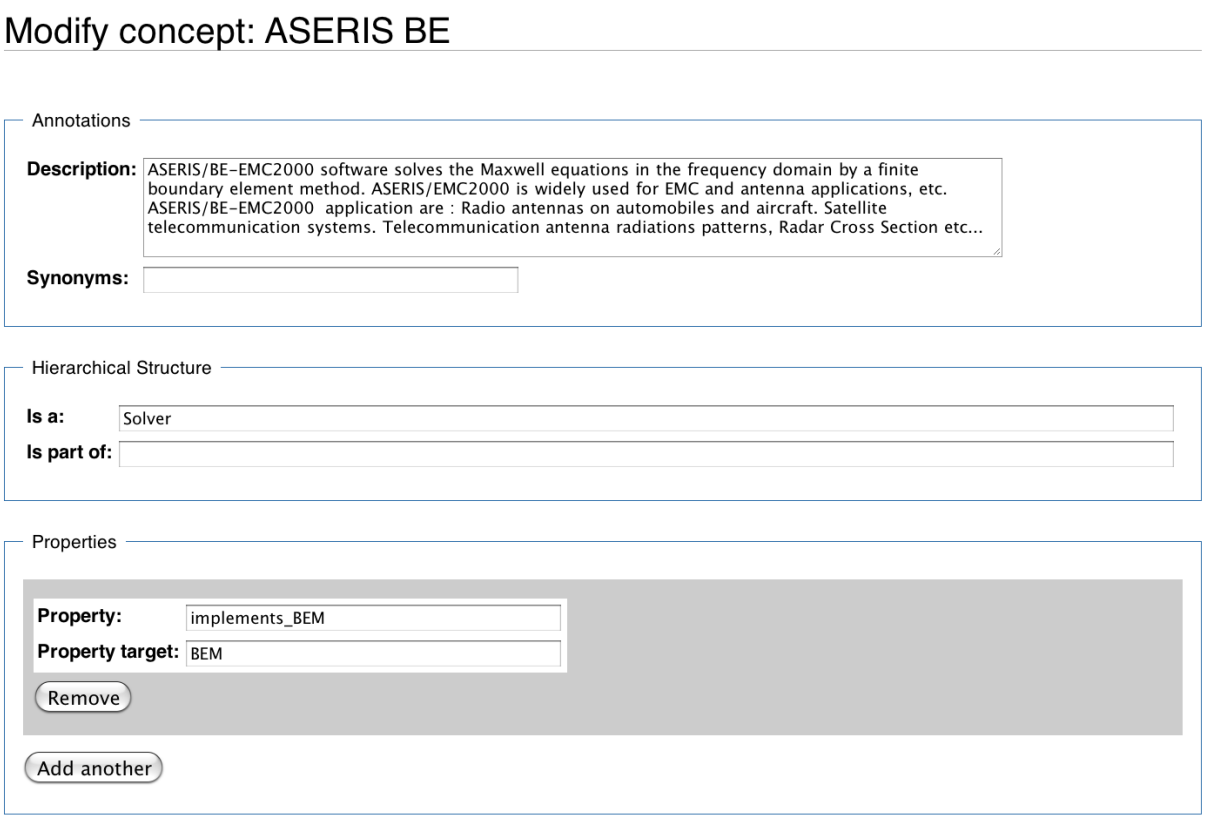
Modify concept: ASERIS BE
Annotations
Description:
ASERIS/BE-EMC2000 software solves the Maxwell equations in the frequency domain by a finite boundary element method. ASERIS/EMC2000 is widely used for EMC and antenna applications, etc. ASERIS/BE-EMC2000 application are : Radio antennas on automobiles and aircraft. Satellite telecommunication systems. Telecommunication antenna radiations patterns, Radar Cross Section etc...
Synonyms:
Hierarchical Structure
Is a:
Solver
Is part of:
Properties
Property:
implements_BEM
Property target:
BEM
Remove
Add another

Figure 5 – Screenshot of a form associated to the domain concept template in MoKi.

For each concept we ask for a “Description” and ”Synonyms” in the *Annotations* box. These elements are modelled as properties of type String in MoKi. We also ask for some relation with other concepts, suggesting pre-defined relations such as ”Is-a” and ”Is-part-of” in the *Hierarchical Structure* box, or allowing the user to add domain dependent relations in the *Properties* box. In the latter case, the user can specify the relation in the “Property” field, and can specify the related concept in the “Property Target” field. As a simple example, in the case of concept *Sweater*, “Property” may contain *Is made of* and “Property Target” may contain *Wool*. Multiple pairs (“Property”, “Property Target”) can be added using the “Add another” button. All these relations are modelled as a property of type Page in MoKi (which basically means they point to other pages in MoKi).

The predefined relation “Is-a” is introduced in the template with the subclass-relationship of OWL in mind. Therefore the informal “Is-a” relation in the Semantic MediaWiki is used with the semantics of the subclass-relationship of OWL (For two concepts X and Y, “X Is a Y” if everything that is an X, is also a Y) and is also automatically transformed in the is-a subclass-relationship of OWL.

The KE starts filling the forms, providing information for the fields. In particular, the autocompletion functionality supports the KE in filling the ”Is a”, ”Is part of”, “Property”, and “Property Target” fields.

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3.4.3.4 Task Template

Figure 6 shows a screenshot of a filled form associated to a task template in MoKi

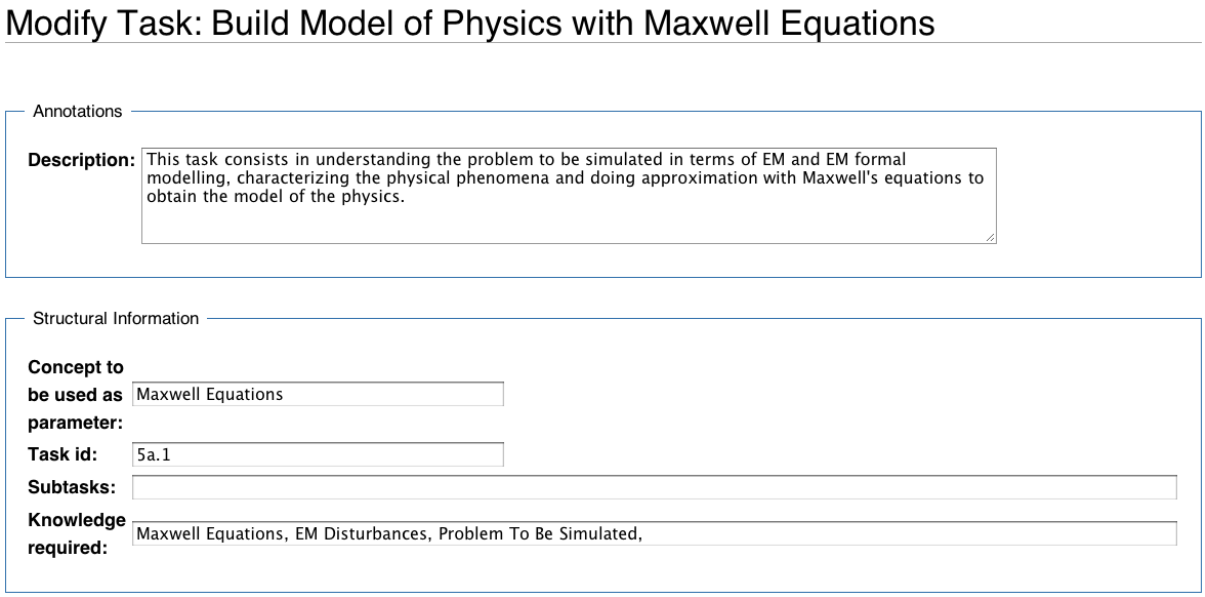
Modify Task: Build Model of Physics with Maxwell Equations
Annotations
Description:
This task consists in understanding the problem to be simulated in terms of EM and EM formal modelling, characterizing the physical phenomena and doing approximation with Maxwell's equations to obtain the model of the physics.
Structural Information
Concept to be used as parameter:
Maxwell Equations
Task id:
5a.1
Subtasks:
Knowledge required:
Maxwell Equations, EM Disturbances, Problem To Be Simulated,

Figure 6 – Screenshot of a form associated to the task template in MoKi.

For each task we ask for a *Description* (in the *Annotation* box), which is modelled as a property of type String in MoKi. In the *Structural Information* box, we ask the KE to fill the following fields, used to collect relations between the task and domain concepts and/or other tasks:

- *Concept to be used as a parameter* (optional). The user can insert in this field a domain concept to be used as a parameter in the task. In inserting the domain concept, the user has to check that:
    - Only one domain concept is allowed;
    - The domain concept has sub-concepts (with respect to the "Is A" relation);
    - The name of the topic occurs in the name of the task (this is needed to assign meaningful names to the specialized tasks).

  This relation is modelled as a property of type Page in MoKi. For more details on the use of parameters within tasks, see Section 7.2.2 in Appendix 1.
- *Task id* (required). This field is used to represent the tasks workflow via numbering. This numbering attribute is specified at the end of the of the current modelling phase, before the formal creation of the task model. This attribute is modelled as a property of type String in MoKi. For more details on the use of the numbering attribute with task, see Section 7.2.1 in Appendix 1.
- *Subtasks* (optional). In this field the user can add other tasks, separated by a comma. For each of these tasks, the relation between it and the task described in the form is as follows: "X has subtask Y" means that Y is a more fine-grained task that is part of X. This relation is modelled as property of type Page in MoKi.
- *Knowledge required* (optional). This relation has been defined for anticipating the more complex Task – Learning Goal – Domain Concept mapping. Doing this, we want to capture early on in the modelling process the relation between tasks and domain concepts. The semantics is as follows: For task X and domain concept Y "X Knowledge required Y" means that in order to successfully perform X, knowledge about the concept Y is necessary. There is

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no formal semantics for this relation however, as this relation will need to be re-examined and formalised in Phase 3 (see Section 3.6). This relation is modelled as a property of type Page in MoKi. If the KE wants to specify knowledge about relevant domain elements already in this modelling phase, (s)he can do this here. The "*Knowledge required*" has to be specified in terms of one or more domain concepts. This is potentially a good moment to discover relevant domain concepts missing in the informal domain model. The "*Knowledge required*" section does not have to be a complete list of domain concepts that are relevant for performing the task. It should be regarded as a possibility to record task - domain concept-mappings that will be taken into account in Phase 3. A task's required knowledge should be specified at the lowest possible level of the task-subtask hierarchy, that is, if a task has sub-tasks, then the required knowledge should be specified only for the subtasks. This is based on the assumption that the tasks' granularity in the task model is such that each complete task is typically carried out by one and the same person.

3.5 Phase 2a. Validation & Revision of Domain + Tasks

3.5.1 Goal

The goal of this phase is to validate, with respect to their correctness and completeness, the domain and task models created with MoKi during the previous modelling phase (see Section 3.4). This validation phase may trigger a revision in MoKi of the models created.

3.5.2 Description

The process of validation and revision of the domain and task models is illustrated in Figure 7.

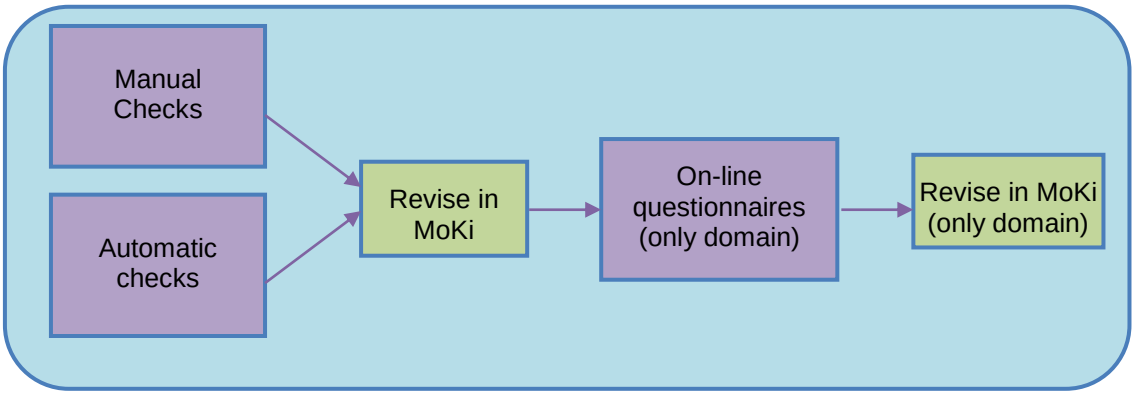

Figure 7 – Validation and Revision of Domain + Tasks

The process is divided in three main activities:

Manual checks. The KEs, supported by the coaches, manually check and validate in MoKi the list of concepts contained in the domain model and the list of tasks contained in the task model according to a list of suggestions. If these suggestions and checks trigger the necessity of revising the models, they update them directly in MoKi.

Automated checks. A list of automated checks is performed on the models to verify certain properties of the concepts and tasks described in MoKi. The result of these checks is provided to the KEs and their coaches, which, according to these results, may decide to revise the models directly in MoKi.

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On-line questionnaires. These questionnaires propose to the KEs statements and questions that are extracted from the domain models contained in the MoKi and aim to verify if the Knowledge Experts agree with those statements. In case of disagreement, the KEs need to manually verify and revise the domain model directly in MoKi.

Activities 1 and 2 can be performed in parallel and concern both models (task and domain). Activity 3 has to be executed after 1 and 2 and concerns only the domain model as described in Section 4.4.1.2.

3.5.3 Supporting Tools, Techniques & Resources

To support the modelling activities in this phase of the IMM, we designed a bunch of tools and guideline documents. The whole process is described in the "Validation & Revision of Domain + Tasks Manual" included in the Annex (Part 3: Validation & Revision of Domain + Tasks), which also contains the list of checks, presented as questions, to be performed in the Manual Checks activity, and suggestions for possible revision according to the results of the (manual and automatic) checks. The automatic checks are performed via a Java tool which performs some SPARQL queries over the OWL models created. The on-line questionnaires are implemented in the Ontology Questionnaire tool. Both the automated checks and the Ontology Questionnaire tools are described in Section 4.4.1. A manual of the Ontology Questionnaire is contained in the "Validation & Revision of Domain + Tasks Manual".

3.6 Phase 3. Modelling of learning goals

3.6.1 Goal

The goal of this phase is to produce the specification of the learning goal model. Starting from the initial alignment between domain elements and tasks produced in Phase 2, the users specify in detail the learning goals using TACT, which was developed within the project and is described in detail in Section 4.3.

3.6.2 Description

In this phase, it can be assumed that the domain and task model are stable in that no relevant domain concepts or tasks are missing. Changing labels and descriptions of tasks and domain as well as removing redundant tasks and domain concepts does not affect the learning goal model. It is also assumed that the necessity of task parameters will sometimes only be recognised in this phase, which is the reason why adding and removing task parameters is directly supported in TACT.

At the end of this phase, a correct and complete learning goal model in OWL is available. This model is directly exported from TACT.

3.6.3 Supporting Tools, Techniques & Resources

The Task-Competence Tool (TACT) supports the activity of creating learning goals based on tasks and domain concepts. The TACT allows modifying the task model insofar as adding or removing task parameters is possible. Furthermore, modelling with task and learning goal parameters is supported in that users mostly need only model learning goals for abstract tasks, while the rest is automatically added by the TACT. The TACT also supports modelling by highlighting tasks which are not described through learning goals and domain concepts which are not used as part of learning goals.

A manual of TACT, included in the Annex (Part 4: TACT User Manual), was distributed to the users, which contains guidelines to modelling and a technical description of how to use the TACT. Guidelines for modelling learning goals were also used for validation and revision support (see Section 3.7).

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3.6.3.1 Guidelines for modelling learning goals

1. Assign to a task all learning goals that are indispensable for a task, and do not assign learning goals that are only “nice to have” for performing the task

The easiest this is to do this by imagining several concrete situations where a person performs the task.
For instance, the task: “Detecting methods and tools” would definitely always require knowledge about which different methods and tools are available. Therefore, the learning goals that are indispensable for the task could be “basic knowledge about: methods”, and “basic knowledge about: tools”. Of course it might also be convenient for the person to have “profound knowledge of: methods”, and “basic knowledge about: tools”. The knowledge engineer has to decide whether these learning goals are indispensable for performing the task, or if they would be just “nice to have”. The distinction between indispensable and dispensable learning goals is important, since modelling learning goals that are just “nice to have” will impair the selection of adequate learning content in a concrete APOSDLE application: APOSDLE users who are seeking help for a task at hand may not be able to judge the relevance of a learning goal related to a task. Additionally, the APOSDLE system has no way to distinguish between necessary knowledge and optional knowledge. If a user who cannot judge the relevance of learning goals for a task is provided with a list of learning goals some of which are only “nice to have”, the user might be overloaded with a lot of information, most of which is not necessary for the task at hand and the user would not be able to distinguish required information from optional information.

2. Assign to a task learning goals for all topics and sub-topics that are required for performing the task. Sub-topics are not inherited from their “parent”-topics.

In order to express that a task requires knowledge about all sub-topics of a certain topic (e.g. all sub-topics of “MS Office” in the domain model, namely “MS Word”, “MS Excel”, and “MS Power Point”), this has to be modelled explicitly. In other words, assigning the learning goal “basic knowledge of: MS Office” does not include “basic knowledge of: MS Word”, or “basic knowledge of: MS Excel”.

3. Differentiate between learning goals referring to the same topic by using different learning goal types

For instance, the EADS-task “Validate and test simulation” might require different learning goals relating to the topic “Simulation Software”. First, the worker might need to have “basic knowledge about: Simulation Software”, i.e. she needs knowledge about the software. Second, the worker might also need to have “profound knowledge of: Simulation Software”. Finally, she might have to “Know how to apply/use/do a: Simulation Software”. In the task “Define the software and hardware architecture” on the other hand, the worker might only need “basic knowledge about: Simulation Software”, and “profound knowledge of: Simulation Software” but she might not need to apply it.

4. Do not rely only on the suggested topics that stem from the “knowledge required”-section in the MoKi.

The “knowledge required” section of the APOSDLE Wiki was filled in a rather early modelling stage. Consequently those “suggested topics” might be incomplete, or some of them might be wrong. Therefore, the KE should not hesitate to re-assess their relevance for performing the task.

5. Perform a second trial to review the task-learning goal assignment

Iterative modelling is encouraged. Usually, at the beginning of a task-learning goal mapping one is rather uncertain about how to do it. During modelling, a sense arises for what is a meaningful mapping and what not. Therefore a first-cut mapping of learning goals to tasks by intuition is suggested. In several case studies, this strategy has proven to lead to success. Finally, at least one more walk through is suggested.

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3.7 Phase 3a. Validation & Revision of Learning Goals

3.7.1 Goal

The goal of this phase is to validate, with respect to its correctness and completeness, the (domain dependent part of the) APOSDLE knowledge base created during the previous modelling phases. This validation phase may trigger

- a revision in MoKi of the domain and task models;
- a revision in TACT of the learning goal model.

3.7.2 Description

The validation and revision of the Learning Goals is built around a single activity, supported by automatic checks, as described in Figure 8.

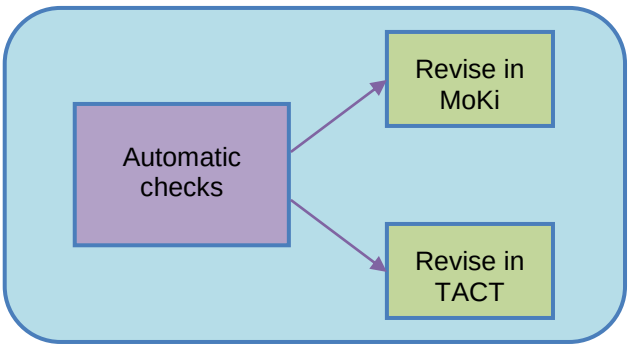

Figure 8 – Validation & Revision of Learning Goals

A list of automatic check is performed on the entire knowledge base to verify certain properties of the concepts and tasks described in MoKi, and of the learning goals created in TACT. In particular, these checks focus on the mappings between tasks and learning goals, and the connection between tasks and domain concepts.

The results of these checks is provided to the KEs and their coaches, which, according to these results, may decide to revise the models using the most appropriate tools, either MoKi (e.g. if a new task need to be added) or TACT (e.g. if a new learning goal needs to be added to a task).

3.7.3 Supporting Tools, Techniques & Resources

Similarly to the first validation and revision phase (see Section 3.5), we designed a bunch of tools and guidelines documents to support the modelling activities in this phase of the IMM. The entire process is described in the "Validation & Revision of Learning Goals Manual" contained in the Annex (Part 5: Validation & Revision of Learning Goals), which also presents the kind of automatic checks performed, together with suggestions for a possible revision of the models according to the results of the checks. The automatic checks are performed via a Java tool which performs some SPARQL queries over the OWL knowledge base created. A detailed description of the automatic checks is available in Section 4.4.2.

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4 Modelling Tools

4.1 Overview

To support the creation of the domain dependent part of the APSODLE Knowledge Base we have developed a set of modelling tools. The set of modelling tools contains:

- MoKi: The MOdelling wiKI – a wiki-based tool which supports the creation of the domain and task models;
- TACT: The Task-Learning Goal Mappings Tool – a JAVA based tool which supports the creation of the learning goal model;
- Validation Tools: some automatic checks and the Ontology Questionnaire – which support the revision and validation of the whole APOSDLE knowledge base created (the former are some JAVA based scripts, the latter is a web-based tool).

In the next three sections of the document, we will describe in details each one of these tools.

4.2 MoKi

MoKi[6] (see (Ghidini et-al. 2009) for more details) is a wiki-based tool which extends Semantic MediaWiki (SMW)[7] to support domain experts in creating the domain and task models. The choice for developing MoKi on top of a semantic wiki was made for several reasons.

First of all, wikis provide an ideal and robust basis for the development of a collaborative tool. They are web-based systems, that is, they are accessible virtually from every place in the world: this feature is particularly suitable since the actors involved in modelling activities may not be located in the same building, or even in the same town, and may not be able to physically participate in meetings. Wikis provide a state of the art robust collaborative tool, and due to the growing popularity of wiki-based web sites (e.g. wikipedia), users are quite familiar with wikis and the editing of wiki pages. Furthermore, the SMW framework already provides several important functionalities such as access control and permissions, tracing of the activity, semantic search, and so on, without the need to install specific client applications. Finally, only a web-browser is required on the end user side to use the system.

The second important reason for choosing a semantic wiki was the fact that the wiki can provide a uniform tool and interface for the (informal) specification of the different components of the APOSDLE Knowledge base, in particular domain and task models. This differs from the usual procedure, where dedicated but often disconnected, modelling tools are used to model each aspect.

As a final reason for implementing MoKi on top of a semantic wiki, the natural language descriptions inserted in a semantic wiki can be structured according to predefined templates, with the help of semantic constructs like properties. As a consequence, the informal descriptions in natural language contain enough structure to be automatically translated in formal models, thus allowing the re-use of informal descriptions for automatic ontology creation.

4.2.1 Describing knowledge in a MoKi page

The main idea behind MoKi is to associate a wiki page to each (simple or complex) element of the formal model so that this page contains an informal but structured description of the element itself.

[6] A demo version of MoKi can be tried out on-line at the MoKi web site: moki.fbk.eu. A detailed description of the current version of MoKi is contained in the MoKi manual, available at the same web site.

[7] www.semantic-mediawiki.org and www.mediawiki.org

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The typical page contains:

- an informal description of the element in natural language (images or drawings can be attached as well). The purpose of this part is to document the model and clarify it to users not trained in the formal representation (e.g., reference to source documents, notes about modelling choices and open problems, etc.). Comments can be added by each user and are not translated to the formal model;
- a structured part, where the element is described by means of triples of the form (subject, relation, object), with the element itself playing the role of the subject. The purpose of this part is to represent the connection between elements of the same model (like class/sub-class relations between elements of the domain model, or task/sub-task relations between elements of the task model) as well as connections between elements of the different models (like the relation denoting required knowledge between elements of the task and the domain model).

This natural language based, but also structured, description provides a natural bridge between formal and informal representation of knowledge. The user fills a page via forms, so he/she does not need to know any particular syntax or language to participate in the creation of the domain and tasks models. All the actors involved in the modelling activities can also interact with each other and exchange further ideas and comments using the SMW's built-it discussion functionality.

Below in Figure 6 an example of a MoKi page describing an element of the domain model is shown:

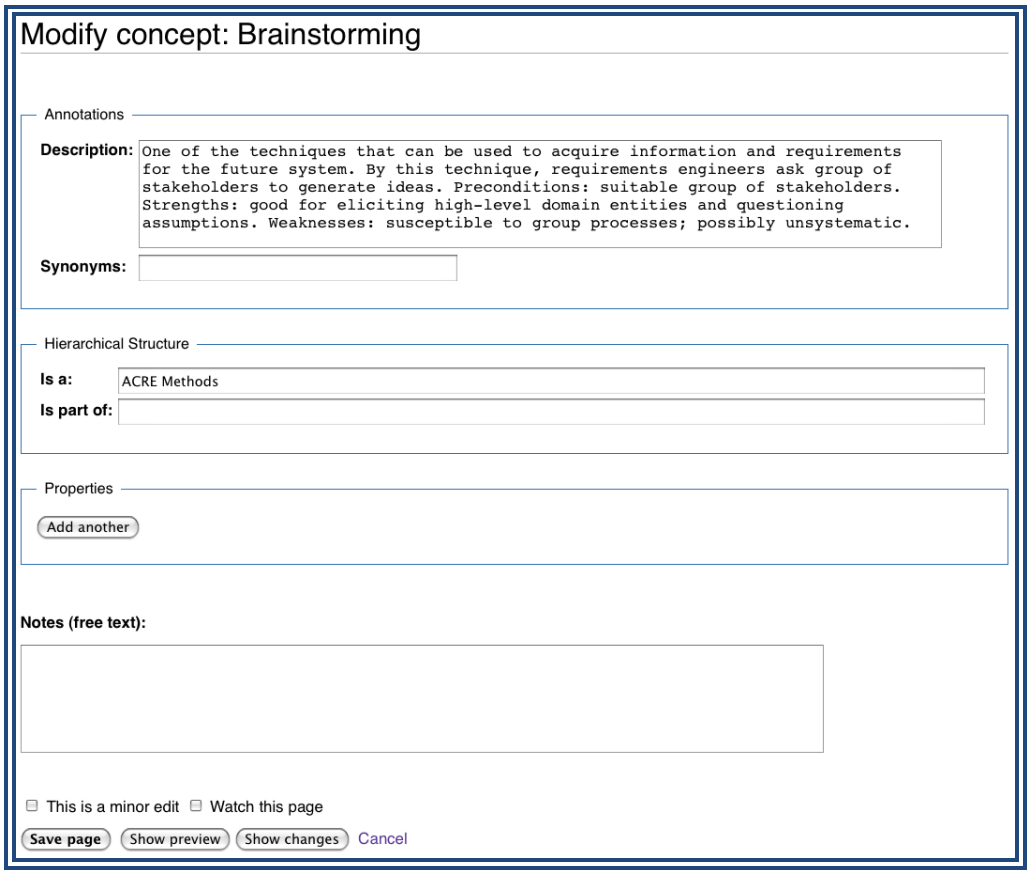
Modify concept: Brainstorming
Annotations
Description:
One of the techniques that can be used to acquire information and requirements for the future system. By this technique, requirements engineers ask group of stakeholders to generate ideas. Preconditions: suitable group of stakeholders. Strengths: good for eliciting high-level domain entities and questioning assumptions. Weaknesses: susceptible to group processes; possibly unsystematic.
Synonyms:
Hierarchical Structure
Is a:
ACRE Methods
Is part of:
Properties
Add another
Notes (free text):
This is a minor edit
Watch this page
Save page
Show preview
Show changes
Cancel

Figure 9 – The page of a domain element in MoKi

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while Figure 10 gives an example of a page describing an element of the task model:

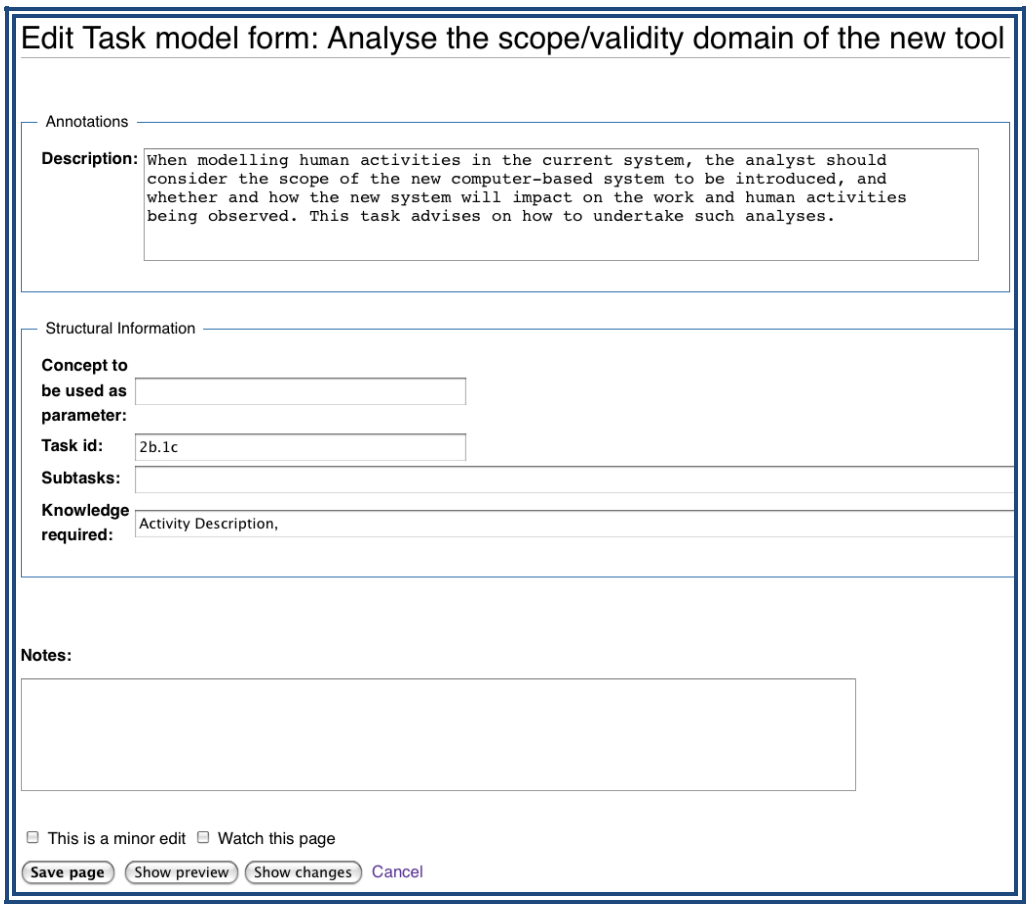
Edit Task model form: Analyse the scope/validity domain of the new tool
Annotations
Description:
When modelling human activities in the current system, the analyst should consider the scope of the new computer-based system to be introduced, and whether and how the new system will impact on the work and human activities being observed. This task advises on how to undertake such analyses.
Structural Information
Concept to be used as parameter:
Task id:
2b.1c
Subtasks:
Knowledge required:
Activity Description,
Notes:
This is a minor edit
Watch this page
Save page
Show preview
Show changes
Cancel

Figure 10 – The page of a task in MoKi

4.2.2 MoKi functionalities

MoKi provides several groups of functionalities to support modelling, all of which can be accessed via a wiki-style menu. This section contains a description of the functionalities currently available. Concerning future extensions, MoKi is built in a modular way in order to facilitate the plugging-in of new or existing state-of-the-art tools.

4.2.2.1 Import Functionalities

We provide three types of import functionalities:

- *Import of available domain/task formal models.* With this functionality the user can set up MoKi with an already available domain or task model instead of starting modelling from scratch. From the technical point of view, the XML serialisation of the OWL formal model is parsed in order to obtain its relevant elements, and a page is created for each one of them.
- *Input of structured lists of elements.* With this functionality the user can create new elements of the models by inserting lists of concepts (or tasks), organized according to predefined semantic structures, e.g. a taxonomy or a partonomy (or task/subtask decomposition structure).
- *Textmining functionalities.* To support the utilization of available unstructured knowledge relevant for the modelling activity, MoKi includes an extension which (i) extracts relevant

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terms from a set of documents, (ii) groups synonymous terms based on WordNet, (iii) clusters a set of documents, and (iv) extracts relevant terms of each cluster.

Whichever functionality is used, the relevant outcome is a list of groups of words. By clicking on a word, the KE creates a new domain concept in the MoKi's domain model. Figure 11 shows screenshots of the central activities of the text mining extension.

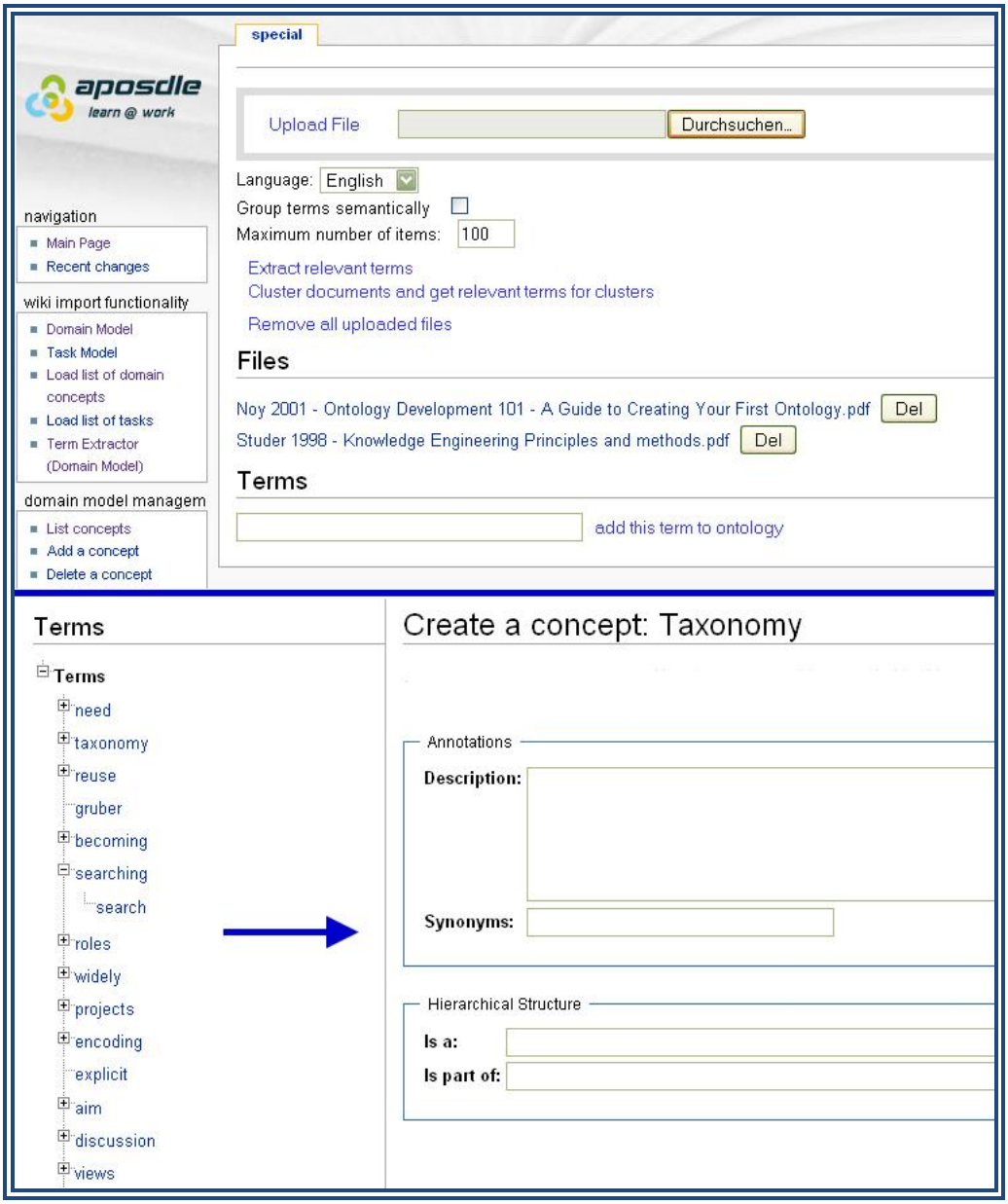

Figure 11 – Upload files, extract relevant terms and cluster the files (top). From automatically extracted terms (bottom left) new concepts in the MoKi can be directly created (bottom right).

4.2.2.2 Model Management Functionalities

This set of functionalities provides the basic functionality each modelling tool necessarily provides: creating, editing and deleting model elements. Depending on the type of element (task or domain concept), pre-defined templates are loaded when an elemant is created or edited.

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4.2.2.3 Visualization Functionalities

These functionalities allow to generate different types of graphical overviews of the models: they help the actors to deal with a global view on the models and not only on single model elements. In particular, the tool allows two kinds of overviews of the model

- In the *tabular-based view*, the user sees a table listing all the elements of the domain model or the task model, where for each element some relevant information is shown, e.g. its description, the concepts of which it is a specialisation (for domain elements), its subtasks (for tasks), and more.
- In the t*ree-based view*, called IsA/PartOf Browser, a tree-like view shows the hierarchy of the domain elements according to either the subclass or part of relation. This tree-like view is dynamically created from the content of the MoKi pages. The user has the possibility to expand/collapse only parts of the tree, thus allowing him or her to efficiently browse even large and complex models. Actually, this is not just a static visualization, since the user can easily rearrange via drag 'n' drop the taxonomy and partonomy of concepts in the domain model, and the changes performed within the browser are propagated to the pages describing the elements involved. Figure 12 shows an example of the tree-based view:

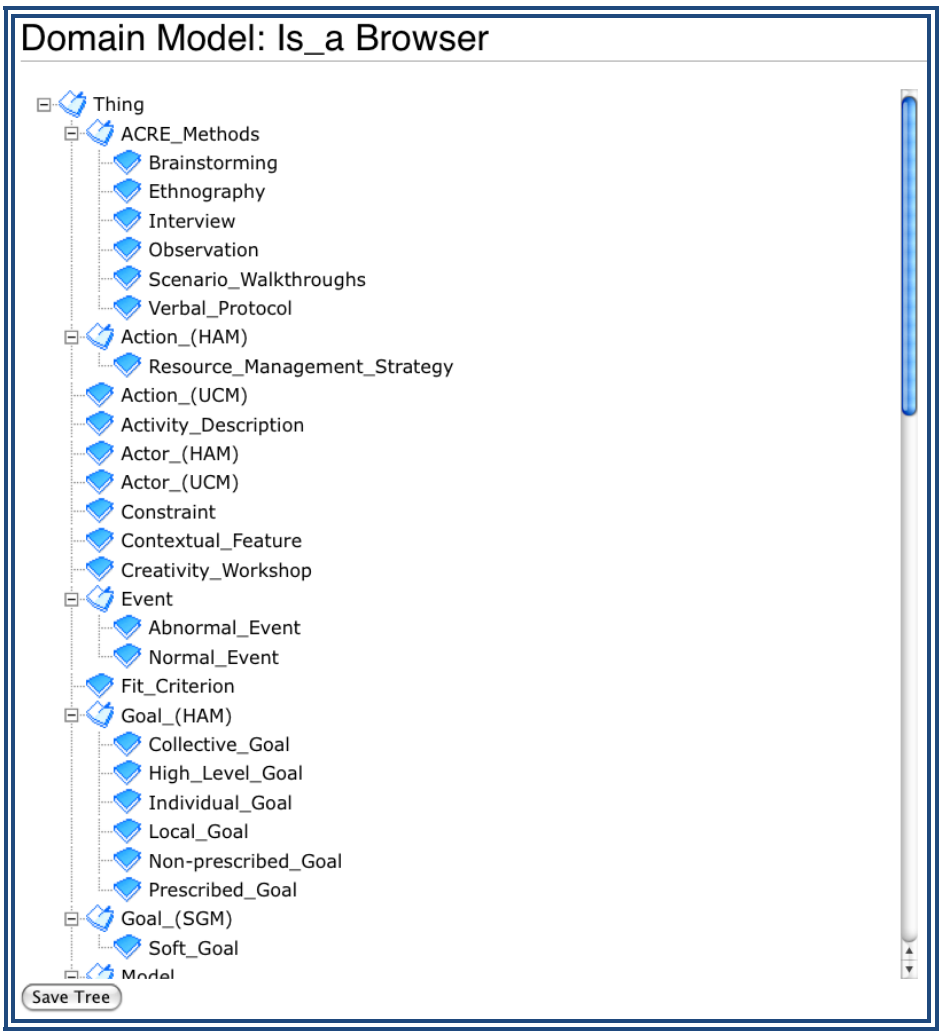

Figure 12 – The domain model IsA Browser

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4.2.2.4 Export Functionalities

These functionalities support the automatic export of knowledge of the domain and task model into standard knowledge representation languages. At the moment, the formal representation for both models is an OWL ontology. The task model and the domain model can be exported separately.

4.3 TACT

The TAsk-Competence Tool TACT supports the activity of assigning learning goals to tasks. It loads the generic part of the APOSDLE KB as well as the domain and the task model of a given learning domain. It also loads the preliminary task-learning goal model created within the MoKi. Of course it supports iterative modelling, i.e. TACT also allows saving and re-loading a task-learning goal model.

It is programmed in Java and distributed as runnable jar-file. It is able to load the files produced by the MoKi, and internally represents the task-learning goal model as OWL ontologies conforming to the structure of the APOSDLE KB (See Appendix 1) To male life easy for knowledge engineers, task-learning goal models are regularly back-uped, and a human-readable changelog collects changes to the models.

A detailed manual of TACT (see Annex part) was given to the application partners. It describes both the conceptual and technical aspects as well as usage of TACT.

4.3.1 TACT functionalities

A simple workflow within TACT consists of loading the APOSDLE Knowledge Base for a specific learning domain. An exemplary screenshot of the TACT is given in Figure 13. The KE specifies for each Task (1) which knowledge (domain concept (2) plus learning goal type (3)) is required.

Furthermore, learning goals can be added to tasks with parameters (or variables), in which case the specialised tasks inherit all learning goals of the parent task.

TACT also supports the modification of tasks by either (i) adding or (ii) removing a variable. In the first case, specialised tasks will be automatically created, while in the latter case, all specialised tasks will be removed from the task model. The semantics of variables is explained in more detail in Appendix 1. TACT supports modelling by highlighting tasks without learning goals, as well as highlighting domain concepts which are not part of any learning goal. Both highlighting functionalities can be switched on and off.

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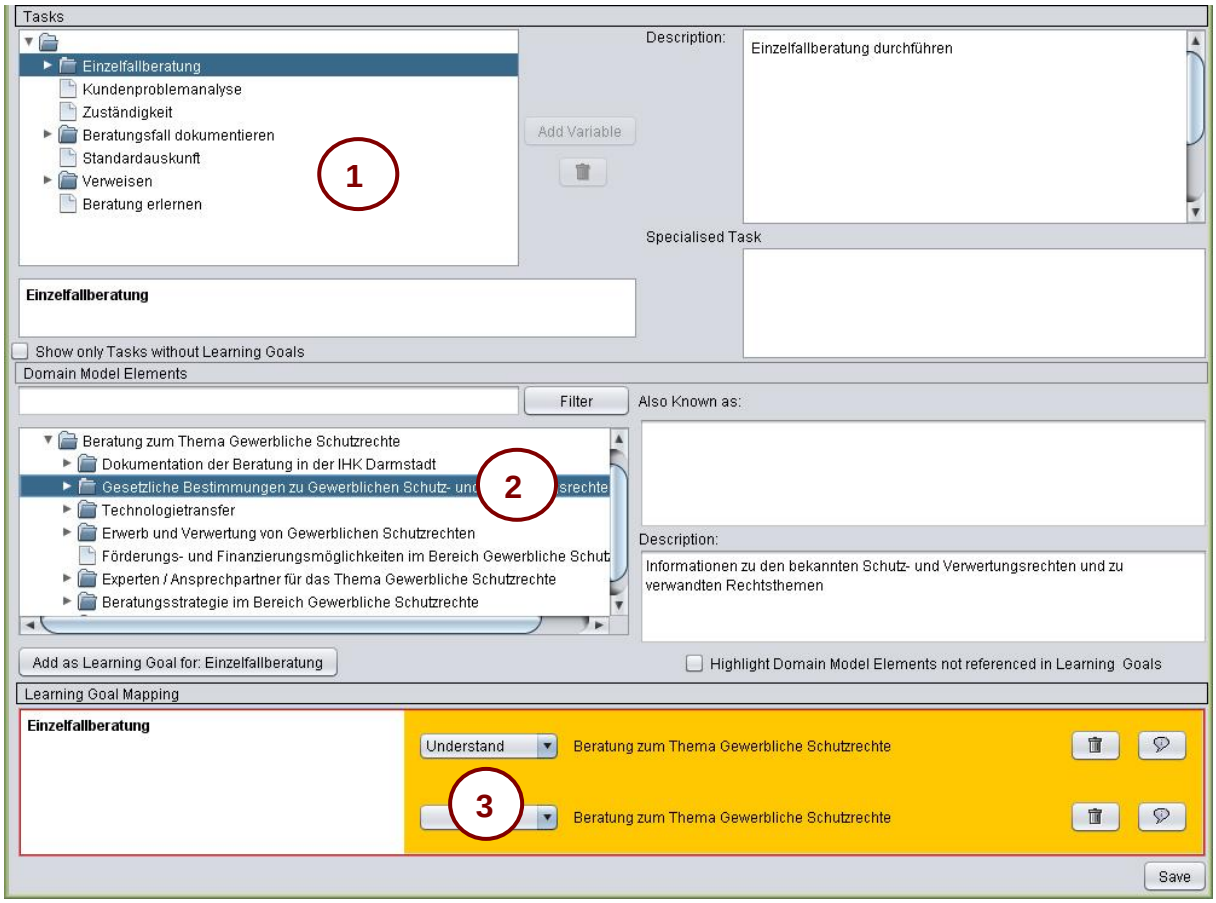

Figure 13 – Overview of the TACT User Interface

4.3.2 Explanations for learning goals

Since a number of learning goals are added automatically, TACT provides explanations for why a learning goal appears next to a task.

1. **This learning goal was created manually in the current session.**

   This learning goal was manually added since the current Knowledgebase has been last opened with the TACT.

2. **This learning goal was imported from an existing learning goal model**.

   This learning goal was already contained in the previous learning goal model. It may have been that this learning goal was imported from text, from the knowledge required in the MoKi. Another case is, that the learning goal model was saved previously and has now been reloaded.

3. **This learning goal was created automatically and contains the same variable as the task.**

   This learning goal contains a variable. It is the same variable as the corresponding task. All specialised tasks will get a learning goal with the corresponding subtopic of the variable. This learning goal can not be deleted except by deleting the variable.

4. **This learning goal was created automatically and contains the topic of the variable in the task.**

   This learning goal is a ground learning goal, which contains the topic of the variable. It is assigned to the task with the variable. This learning goal was added automatically based on a heuristic. It can be deleted.

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5. **This learning goal was created automatically and contains a sub-concept of the variable in the task.**

   This learning goal is assigned to a specialised task. It contains a subtopic of the variable, namely the subtopic with which the specialised task specialises the task with the variable. This learning goal can not be deleted except by deleting the variable. This however will also remove the specialised task.

4.4 Validation tools

These tools – some automatic checks and the Ontology Questionnaire – support the revision and validation of the entire APOSDLE knowledge base created. The automatic checks are performed via a JAVA tool, while the Ontology Questionnaire is a web-based tool.

4.4.1 Validation & Revision of Domain + Tasks

These checks are performed after the usage of the MoKi, and concern the task and domain models. In addition to some manual guidelines used to validate the list of concepts contained in the domain model as well as the list of tasks contained in the task model of the MoKi, we have implemented some tools to help users in revising the models created:

1. **Automatic checks**. This part consists of a list of automatic checks performed to verify certain properties of the concepts and tasks described in the MoKi. The results of these checks are sent to the Application Partners and coaches to help them with revising the models contained in the MoKi.
2. **Ontology questionnaire**. This questionnaire, accessible on-line, proposes statements and questions to the Knowledge Experts that are extracted from the domain model contained in MoKi and aim to verify if the Knowledge Experts agree with those statements (if not, this obviously triggers a request for some manual verification and revision of parts of the models contained in the MoKi).

4.4.1.1 Automatic checks

These checks are performed automatically via some Java tools based on Jena Library and the Pellet reasoner: the OWL models of task and domain are exported from the MoKi, and these tools are applied off-line. The tools implement some SPARQL queries on the OWL/RDF files containing the models. The output consists of a text file containing:

Domain Model Section

- a list of all domain elements for which no description has been provided;
- a list of all the top level concepts, that is concepts at the first level in the class/subclass hierarchy, having no children.

Task Model Section

- a list of all tasks for which no description has been provided;
- a list of all tasks with variables for which:
  - the concept used as variable is not in the list of domain concepts;
  - the concept used as variable is not part of the name of the task;
  - the variable attached to the task is different than the variable used in its supertask.

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- a list of all concepts which are used in the “knowledge required”-field of any tasks, but that are not in the list of domain concepts;
- a list of all tasks having an empty “knowledge required”-field;
- a list of all tasks missing the Task ID (the number used to model the workflow of the processes);
- a list of all task having names longer than 30 characters.

4.4.1.2 Ontology Questionnaire

This questionnaire is meant to propose statements and questions to the Knowledge Experts that are extracted from the models contained in the MoKi and aim to verify if the Knowledge Experts agree with those statements (if not, this obviously triggers a request for some manual verification and revision of parts of the models contained in the MoKi). The questionnaire concerns the domain model.

The purpose of the ontology questionnaire is to let a Knowledge Expert verify the “knowledge” that can be inferred from an ontology and remove it in case it was not intended. The rationale behind this is that knowledge expert and knowledge engineer might encode their knowledge in the ontology in such a way that they do not agree with everything that can be inferred from it. After seeing the inferred statements, the knowledge expert or the knowledge engineer might disagree with an inferred statement and wants to remove it. This is not directly possible because it is inferred and not stated. The ontology questionnaire finds the reason for an inferred statement, and lets the user remove the reason for the inference. With the statements which lead to the unwanted inference removed, also the unwanted inference is removed from the ontology.

The ontology questionnaire shows a list of inferences to the knowledge expert. The knowledge expert should read through these statements carefully. In case of disagreement, the knowledge engineer can tick the statement, and by clicking the “Justify!” button at the bottom of the list, he/she gets the reason why this statement was inferred.

Figure 14 shows the page of the Ontology Questionnaire containing, in the top half, the list of statements entailed by the domain ontology, and in the bottom half the explicitly modelled statements (displayed for user convenience).

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Entailed Statements:
In this box you see the statements (axioms) that are entailed (inferred)by the specified ontology. You can get a justification by se
ontology, see the second box below!
Rank_Correlation_Test subClassOf Test
Two-Way ANOVA subClassOf Parametric Test
F-Test subClassOf Test
ANOVA subClassOf Test
One-Way_ANOVA subClassOf Parametric_Test
One-Way_ANOVA subClassOf Inferential_Statistics
One-Way_ANOVA subClassOf Comparing_Means
One-Way_ANOVA subClassOf Test
Linear_Correlation subClassOf Inferential_Statistics
T-Test subClassOf Test
justify!
Axioms:
In this box you can see the axioms the specified ontology exists of; by checking one of the checkboxes (and clicking the remove
Standard_Deviation subClassOf exists Square_root_of.Variance
isPartOf is transitive
P-Value subClassOf Value
Operates_on range (Z-Value or Crosstab or Standard_Deviation or Mean)
Results_in domain (Two-Way_ANOVA or General_Linear_Model__GLM or Linear_Correlation or F-Test)
Is_type_of range (T-Test)
Alpha subClassOf Value
Is_based_on domain (Hypothesis_Testing or ANOVA or Linear_Regression)
T-Test subClassOf Parametric_Test

Figure 14 – Entailed and explicitly modelled statements from the SDA domain.

The ontology questionnaire was deployed as a web application on a server hosted by the Know-Center. Its distribution was accompanied by a detailed manual contained in the Annex (Part 3: Validation and Revision of Domain + Tasks).

4.4.2 Validation & Revision of Learning Goals

These checks are performed at the end of the modelling phase involving the usage of the TACT, and are used to refine and tune the models modified and/or created in TACT. The change of the models triggered by the list of checks has to be performed manually in MoKi and/or in TACT.

The checks are performed automatically via some Java tools: the OWL files of the whole knowledge base are given as input to these scripts, which are based on Jena Library and Pellet reasoner. The tools actually implement some SPARQL queries on the OWL/RDF files describing the models. These scripts return a text file containing:

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General Statistics Section

- Some general statistics on the models: the number of Tasks, the number of Domain Elements, the number of Learning Goals, and the number of Task/Learning Goal assignments;

Connection between Task Model and Learning Goal Model Section

- a list of all tasks having no learning goals attached;
- a list of all tasks having exactly one learning goal attached;
- a list of all tasks having at least five learning goals attached;
- a list of tasks having the same set of learning goals attached;
- a list of all learning goals not attached to any task;
- a list of all learning goals attached to exactly one task.

Connection between Domain Model and Task Model Section

- a list of all domain elements not connected (via learning goals) to any task;
- a list of all domain elements connected (via learning goals) to exactly one task;

Learning Goal Types Section

- a list of the learning goal types never used.

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5 Qualitative Evaluation and Comparison with the first version of the methodology

At the end of the modelling activities for Prototype 3, similarly to what has been done for the first version of the IMM, we asked the Application Partners and the Coaches to provide some feedback and comments on the modelling methodology proposed. The feedback has been collected from a questionnaire sent to the Application Partners and their Coaches. The questionnaire we asked them to fill is basically the same as the one proposed at the end of the first version of the IMM (except for some minor changes due to the different methodology structure), and is composed of specific questions for each phase of the methodology. The filled feedback questionnaires are collected in the Annex (Part 6: Filled Feedback Questionnaires on the Integrated Modelling Methodology).deliverable

The feedback collected allowed us to provide a first evaluation of the second version of the methodology. This evaluation is organized in two parts.

In Section 5.1, we report the general comments on the entire methodology, as well as the specific feedback for each of its phases. Although the modelling activities in APOSDLE has ended by the time of writing this deliverable and no future developments of the methodology and supporting tools within the project is currently scheduled, we decided anyway to present possible improvements or changes of the methodology triggered by the feedback received which could be considered in some future enhancement of the APOSDLE system.

In Section 5.2, we present the results of the summarizing qualitative content analysis that was applied for the answers the Application Partners and Coaches provided in the questionnaires for both versions of the IMM, in order to provide a comparative qualitative evaluation of the first and second version of the IMM.

5.1 Qualitative Evaluation

This section organizes the evaluation as follows: first, we consider some general comments on the entire methodology; then, for each phase of the methodology, we report the specific feedback for that phase. For each comment, we report if it was made by Application Partners (APs) or by Coaches. Furthermore, if a comment suggests some improvement or modification of the methodology, we propose one or more possible actions to take or to solve the problem in future versions of the methodology. The feedback for the single phases concerns several different aspects: it goes from comments on general aspects to specific comments on technical problems. In order to help the reader we tag the comments for each phase with one of the following labels:

- [GENERAL] – we tag with this label those comments about a general aspect of a phase;
- [TOOLS] – we tag with this label those comments about tools and techniques proposed to support the methodology;
- [ORGANIZATION] - we tag with this label those comments about organizational aspects of the methodology.

Note that the feedback questionnaire stimulated the Application Partners and coaches to comment also on more general issues – not necessarily related to the methodology. In this section we process only the feedback that deals directly with the methodology.

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5.1.1 General Feedback on the Methodology

From the experience of producing the APOSDLE knowledge bases for Prototype 2 we have identified the following general issues:

- **Importance of knowing the APOSDLE system and the kind of models it needs.** The experiences from APOSDLE Prototype 2 were very useful. We knew how the domain concepts and the list of tasks have to look like. It was extremely helpful that all domain experts involved knew APOSDLE P2, its functionality and possibilities. (Source: APs, Coaches) Furthermore, Application Partners were much more experienced/did work more independently. Main Work was done by application partners. (Source: Coach)

  *Comment***:** The methodology should provide guidelines and resources for better explaining: how the final models should be and what is the role of the knowledge base inside the APOSDLE system. An option could be to show, in the early stages of the modelling activities, a demonstration of the APOSDLE system, focusing on how the models influence the behaviour of the system and the quality of the learning support provided.

- **Involvement of domain experts in modelling activities.** Domain expert are not performing the modelling. Modelling needs still a person with the qualification of a knowledge engineer. Modelling should be so easy that domain experts can do it themselves - knowledge engineering skills are quite rare in small and medium sized companies. (Source: AP)

  Comment: The methodology, as it is now, does not require an active role of domain expert in the modelling activities. However, the methodology relies on a committed Knowledge Engineer from the company. What to do if this person is not available is a general issue, common to many complex systems development projects that require some effort to be customised. A possible solution could be to provide external Knowledge Engineers, instead of coaches, but this is a decision which should be considered by the entire APOSDLE consortium and not only related to the Integrated Modelling Methodology.

- **Importance of coaches.** The coaching effort is still large. It would even be much large if the application partners would not be as experienced as they are. Without a knowledge engineer, the modelling process would not be possible. Domain experts themselves cannot finish the modelling on their own. However, our overall impression is, that the amount of time to be invested is acceptable. All in all, we can imagine the opportunity for an “APOSDLE company” (i.e. exploitation strategy) to sell modelling as a service, which can be performed (and sold!) supported by the IMM in due time and quite independently from the domain to be modelled. From our experience with coaching/developing several models with several partners we perceive the IMM as domain-independent enough “to be sold”. (Source: Coach)

  *Comment***:** The methodology should provide guidelines and support also for coaches in order to improve the quality and reduce the effort of coaching.

- **The modelling process is still very time consuming.** This disadvantage has hardly changed. This can be accepted for a test situation but not for a “real world” application. Speeding up modelling is crucial. (Source: APs)

  Comment: As we noted already in the Deliverable D1.3, for a system like APOSDLE it is impossible to completely eliminate modelling effort. However, according to the filled questionnaires received, with respect to the first version of the methodology, the time consumed dealing with technical aspects regarding the tools has substantially reduced. Furthermore, thanks to the experience gained in developing the models for P2, in P3 we have been able to provide a better quantification of the effort required for each step of the methodology, and this has helped coaches and APs to better plan their work.

- **Supporting Tools have been remarkably improved.** There is a huge difference between the MOKI and the Wiki we used last year. The TACT tool is much improved from the point of usability. (Source: APs, Coaches)

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- **Importance of tools supporting validation and revision.** The automatic checks turn out to be very useful to reach the objectives. (Source: APs, Coaches)
- **One single tool covering all the phases.** It would be nice to have everything integrated in one tool. After the final checks I found a task where I wanted to change the labeling…this can just be done by technical partners. Also I now have to update the MOKI according to the changes I did in TACT (Adding/deleting variables)…the best thing would be the have one tool, where everything is changed automatically. (Source: AP)

  Comment: A feasible solution could be to integrate in MoKi all the other modelling tools (TACT, Validation Tools) in order to have a unique interface/tool covering all the phases of the methodology.

5.1.2 Feedback on: Phase 0. Scope & Boundaries

5.1.2.1 Positive Feedback

- [GENERAL] We could easily build a collection of relevant learning resources. (Source: AP)
- [GENERAL] We had created the questionnaire on APOSDLE application domains, which to me was also a very useful tool for coaching the process selecting an adequate APOSDLE domain. (Source: Coach)
- [GENERAL] The discussions with the AP helped to focus very early in the process and reduced effort. (Source: Coach)
- [GENERAL] The iterative process using graphical tools from the beginning turned out to be much easier. (Source: Coach, AP)

5.1.2.2 Negative Feedback

- [GENERAL] It was difficult to represent all the complexity of our task model due to the only one variable limitation. (Source: AP)

  Comment: The inclusion of multiple variables would have led to a very high complexity of the meta-model, since it is not trivial to define inter-dependencies of variables and desirable rules for inheritance/propagation along multiple hierarchies. We believe that the approach of representing multi-variables in tasks within the structure of the domain model has been quite successful.

5.1.3 Feedback on: Phase 1. Knowledge Acquisition

5.1.3.1 Positive Feedback

- [GENERAL] We had a good overview and a structure of our AP domain after this step. (Source: Coach)
- [GENERAL] This step was important to structure and facilitate the proceeding steps. (Source: Coach)
- [GENERAL] Knowledge experts were strongly involved. (Source: AP)
- [GENERAL] Using Card sorting in several rounds, we lead the AP to get an overview and structure the domain and contents themselves. (Source: Coach)
- [ORGANIZATION] Everything was done by the AP, not very much coaching effort (Source: Coach)

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- [ORGANIZATION] We performed together with our Coach four very nice workshops using sophisticated knowledge elicitation techniques. After these workshops we had a lot of useful data. (Source: AP)
- [ORGANIZATION] We tried out several additional KE techniques (improved version of Card Sorting, Chapter Listing, Step Listing, etc.). Again, it was very advantageous to start from an existing model which needed to be improved instead starting from scratch. (Source: Coach)
- [ORGANIZATION] To gather the knowledge of our domain experts, we made several interviews and smaller workshops with them. These interviews were very comfortable and we got a lot of knowledge from them, so that we could gather new domain concepts. Again this step was not so difficult, but we spent a lot of time interviewing and observing the domain experts. The domain experts were this time more open for interviews and knowledge elicitation because they had a better understanding of the APOSDLE system and modelling process. (Source: AP)
- [TOOL] It is very nice that the textmining functionality is now integrated to the MoKi. That makes it very easy to add the extracted concepts to the models. (Source: AP)

5.1.3.2 Negative Feedback

- [GENERAL] Unsolved problem: Experts' knowledge is expanding continuously. How could we transfer this knowledge growth to APOSDLE without repeating workshops and interviews continuously? (Source: AP)

  *Comment***:** This is a typical modelling problem, which goes beyond this methodology and the scope of the APOSDLE project.

- [GENERAL] It is a challenge to reduce the data from the domain experts to tasks and concepts…also it is not very easy to find overlaps: Each DE has his own view on the things and his own view on how important some things are. (Source: AP)

  *Comment***:** This is a general knowledge acquisition problem, which goes beyond this methodology and the scope of the APOSDLE project. Anyway, support by coaches (based on their experiences of supervising/supporting this phase in previous deployment of the system) could be effective to solve these issues.

- [ORGANIZATION] This step is very time consuming. Difficulties to find the right dates. We had to travel. This step took a lot of time. (Source: APs)

  Comment: This phase is a crucial one in the methodology and the quality of the models created is highly influenced by its output. Hence, investing some time in it will be rewarding in the end. Nevertheless, a possibility could be to provide more time effective strategies to perform the entire knowledge elicitation/acquisition phase. Furthermore, to reduce costs/time spent travelling, some techniques (e.g. interviews) could be also performed via videoconferencing tools.

- [ORGANIZATION] Further formal guidance for transforming card sorting into a hierarchy would be helpful. (Source: Coach)

  Comment: The methodology should provide detailed guidelines to support the formalization of the card sorting results (maybe investigating the state of the art for already available results/documents)

- [ORGANIZATION] DE should not be involved in too similar knowledge elicitation sessions after each other; the DE might have the feeling that they are giving "the same information" again and again. This means, knowledge elicitation sessions at this stage need to be carefully planned. (Source: Coach)

  Comment: The knowledge elicitation phase could be planned in detail in advance in order to avoid the above issue. If there are a considerable number of domain experts available, one

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possibility could be to perform some technique with one group of experts, and other techniques with other groups. If the number of domain experts is very small, an option could be to apply only one knowledge elicitation technique (the most appropriate one), instead of several as is done now.

- [TOOL] There are some minor usability issues…uploading a document and then adding the topics to the ontology might not be very easy and intuitive for some users. The text mining functionality still doesn't work very well with long or German documents – but it was sufficient for us. (Source: AP)

  Comment: The text mining functionality which is integrated with MoKi should be improved.

- [TOOL] We did not use the text mining functionality due to poor experiences with this tool last year. We extracted the knowledge from the digital resource intellectually. We analysed the structure of the resources and gathered a number of candidate domain concepts. It was not difficult, but it took a lot of time. (Source: AP)

  Comment: The text-mining functionality should be improved.

5.1.4 Feedback on: Phase 2. Modelling of domain + tasks

5.1.4.1 Positive Feedback

- [GENERAL] Significant improvements were done for P3 informal modelling tool (MOKI) and process: template has been better organized and it was not necessary to KE to know the detailed Wiki syntax to enter data. KE was able to see the entire set of tasks (their description) with the learning goals (domain concepts). (Source: AP)
- [GENERAL] After this step we had all relevant domain concepts and tasks within clearly structured and transparent models. (Source: AP)
- [GENERAL] The task model was much easier, just the numbers had to be added. (Source: Coach)
- [GENERAL] Very good support to KE in knowledge structuring and formalization. (Source: AP)
- [GENERAL] Use of variables in informal model reduced KE workload. We have some concepts which has about 15 subconcepts labelling different techniques. Therefore it really makes sense to use these variables. (Source: APs)
- [GENERAL] I think that one variable in the task is a useful means to reduce modelling efforts. However, we have learned (e.g. from the final number of tasks in the model) that using variables leads to a huge number of tasks very easily. This has to be taken into account for coaching. (Source: AP, Coach)
- [GENERAL] The tool chosen is adequate for this step of the methodology, especially if domain experts are active involved in the modelling phase. (Source: Coach)
- [GENERAL] The models after this step were already in a almost final form. This was a result of the intuitive MoKi. (Source: Coach)
- [ORGANISATIONAL] Some internal document were prepared on task and domain model and were very useful to quicker the process. (Source: AP)
- [ORGANISATIONAL] There were less tools, especially not using YAWL did save a lot of time for us. (Source: Coach)
- [ORGANIZATION] It has been much better to have a separate MOKI for each partner (Source: AP)
- [TOOL] MoKi much easier to use, less tools. More experience. (Source: Coach, AP)

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- [TOOL] The MoKi has much improved since last year. It is as comfortable to use as Protégé. (Source: APs)
- [TOOL] There is a huge difference between the MoKi and the Wiki we used last year. MoKi is easier to handle, a user can model very quick due to the import function, and the browse functionalities allow a good conceptual overview over the models. (Source: APs)
- [TOOL] Using the Semantic MediaWiki was very easy this time. Changing content was more intuitive, the overall process was much faster. (Source: Coach. APs)
- [TOOL] Possibility to create groups of concepts and task with the very easy List typing. (Source: AP)
- [TOOL] It was easy to add variables to tasks, thanks also to the auto-completion functionality in the MoKi. (Source: Coach, AP)
- [TOOL] The MoKi has been used in a collaborative manner, since coaches were able to monitor and provide feedback on the work of application partners. (Source: Coach)

5.1.4.2 Negative Feedback

- [GENERAL] When creating variable, it is difficult to have clear vision of how they will be used further in the P3. (Source: AP)

  Comment: The methodology should provide better support and explanation (also providing some examples) on how the use of variables reduces the modelling activities, especially when specificying learning goals, and their connection with tasks.
- [TOOL] There were deleted concepts that still remained available on the wiki. (Source: AP)

  Comment: This issue has been already solved during the APOSDLE modelling activities.
- [TOOL] The only remark is that KE should have the possibility to export himself the MoKi's files in OWL. Currently this function is not available for the KE. (Source: AP)

  *Comment***:** Due to a server configuration issue, we have been forced to disable direct user access to this functionality. However, one of the aims of MoKi is to allow a user to directly obtain the OWL version of their model.

5.1.5 Feedback on: Phase 2a. Validation & Revision of Domain + Tasks

5.1.5.1 Positive Feedback

- [GENERAL] Since the models were kept simple, the modelling process in general was much easier. There were just minor changes in this step. (Source: Coach)
- [GENERAL] The check made us sure to have completed the informal model before going into the formal modelling phase (Source: Coach, AP)
- [GENERAL] The models developed into the MoKi have been translated into valid OWL formal models, without any effort from application partner and coaches. (Source: Coach, AP)
- [GENERAL] The objective and explanation of this step was clear. (Source: AP)
- [GENERAL] No domain experts involved. (Source: AP)
- [TOOL] The good check results are due to the improved MOKI. (Source: AP)
- [TOOL] The MoKi's usability was much better than in the previous year. Therefore, the models were in a good shape from the beginning. (Source: Coach)
- [TOOL] The visualization functionalities (in particular the "Is a" and "Is part of" browser) participate in validation end revision. (Source: Coach, AP)

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- [TOOL] The tools were adequate for the models. (Source: Coach, APs)
- [TOOL] The automatic checks turn out to be very useful to fulfil the objectives. (Source: Coach, APs)
- [TOOL] The check report delivers a good overview, also some hints from the coaches were useful. Some relations between concepts didn't make any sense and were detected through the formal checks and the coaches. (Source: AP)

5.1.5.2 Negative Feedback

- [GENERAL] Is-part-of-relations has to be changed into is-a-relations. This step did not produce much effort, we still don't understand why relations are provided at the beginning and have to be changed at the end because of technical reasons. Furthermore, the current model does not exactly express what the AP did want to model. (Source: Coach, AP)

  Comment: The guidelines and manuals supporting the methodology and tools should emphasize how the informal descriptions provided in MoKi are actually formalized in the OWL models.

- [TOOL] The formal check report was very long. (Source: AP)

  Comment: The length of the check results file depends on the number of the checks performed, and the number of entries violating the checks. While the first number is fixed, the second depends on the models produced. An option would be to find a more compact way to represents the results of the checks (maybe a table instead of a plain text file).

5.1.6 Feedback on: Phase 3. Modelling of learning goals

5.1.6.1 Positive Feedback

- [GENERAL] Learning goal types are now clearer and more adequate for us. (Source: AP)
- [TOOL] The installation and use of TACT tool is very easy and the user manual contains quite clear definitions and examples of the different competency types. (Source: AP)
- [TOOL] The TACT manual was very useful to understand the meaning of learning goal types and how to use the tool. (Source: Coach, AP)
- [TOOL] The TACT tool has much more improved from the point of usability. (Source: AP)
- [TOOL] It is very useful to have the variables created in MoKi already as a hint in the TACT. (Source: AP)
- [TOOL] Having the descriptions available and automatic generated learning goals is better. The learning goals are easier to understand and better to apply. (Source: AP)

5.1.6.2 Negative Feedback

- [GENERAL] The learning goals are not the same if the user performs a given task for the first time or for a second time. We decided to assign to the task all the learning goals that are relevant in both situations. However it means that the learning goal model contains several tasks with a great number of learning goals. (Source: AP)

  *Comment***:** Assigning to a task all learning goals that are relevant for it is the correct way to model the learning goal model. This is true even if a large number of learning goals is finally assigned to each task. A quality indication for the learning goal model is that the same learning goals are assigned to multiple tasks. Adaption to users within APOSDLE is not achieved by executing the same task multiple times, but by executing different tasks with the same learning goals over time.

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- [TOOL] Of course TACT can be improved. As an example of possible improvements: the models visualization (identification of super tasks and subtasks, relations between concepts, presentation of process order instead of the alphabetical list of tasks). (Source: APs)

  *Comment***:** This is a usability issue of TACT. Further development of the TACT will profit from this feedback.

- [TOOL] We had problems in understanding the inheritance within the tool (TACT). We thought if a class has the learning goal type "profound knowledge about", the subclasses would inherit this learning goal type. This was not the case. So we had to define the learning goal type for every subclass although the class had already this learning goal type. This procedure took a lot of time. (Source: AP)

  *Comment***:** This may be due to a misunderstanding of inheritance in general. Learning goal types are not inherited by domain concept (class). Therefore it is possible that one domain concept is used together with different learning goal types for different tasks. This is the intended behaviour, but obviously the communication / explanation to the knowledge engineers was lacking.

- [TOOL] Another difficulty was that our multi-hierarchies were not visible within the tool, although they were within the Semantic Media Wiki. (Source: AP)

  *Comment***:** TACT currently only supports the visualisation of the OWL class/subclass hierarchy. Further development of the TACT may profit from this feedback.

- [TOOL] (about Adding variable in TACT) When you know where you have to do it (highlight respective task and topic) then it is easy. But I first did not know how to do this. (Source: AP)

  *Comment***:** This is a usability issue of TACT. Further development of the TACT and its manual will profit from this feedback.

5.1.7 Feedback on: Phase 3a. Validation & Revision of Learning Goals

5.1.7.1 Positive Feedback

- [TOOL] The results of automatic checks helped to reduce the effort. They provided a good feedback what points still have to be closer checked. (Source: Coach)
- [TOOL] The automatic formal models checks turn out to be very useful to fulfil the objectives. (Source: Coach, APs)
- [TOOL] Anew, the check report gives a very nice overview. I also liked very much the Spreadsheet that the TACT produces. With these two documents it is quite easy to check everything. (Source: AP)

5.1.7.2 Negative Feedback

- [GENERAL] The whole process can only be performed by knowledge engineers and not by domain experts. (Source: Coach, APs)

  Comment: The methodology could provide more detailed guidelines (showing some typical examples) on how to react to the results of the checks. Anyway, coach support is crucial in this phase.

5.2 Comparison of feedback for Prototype 2 and Prototype 3

A summarizing qualitative content analysis was applied for the answers of the KE and Coaches in the questionnaires for the second APOSDLE Prototype (P2) and the third APOSDLE prototype (P3).

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The qualitative analysis was conducted in a two-step process: First, each answer (mostly one sentence) of each respondent in the questionnaires was assigned to one of the modelling phases: *Scope and Boundaries*, *Knowledge Elicitation* (both from documents and experts), *Modelling of domain and tasks*, *Validation and Revision of Domain + Tasks*, *Modelling of learning goals* and *Validation and Revision of Learning Goals*.

Second, similar answers were paraphrased into statements. For instance, the answers of a respondent A "Another problem was, that experts don't have time" and of a respondent B "each hour of the real experts is so hard to get" were summarised into the statement "Experts had very little time". The resulting statements are listed in Appendix 2.

For our analyses, we could draw upon filled questionnaires of 4 knowledge engineers (ISN, CCI, EADS, CNM) and 2 coaches (KC, SAP) for P2, and upon the questionnaires of 3 knowledge engineers (EADS, ISN, CCI) and 3 coaches (SAP, KC, FBK) for P3.

Table 1 gives an overview over the assignment of coaches to knowledge engineers (KE) for modelling APOSDLE's second and third prototype (P2 and P3).

Prototype 2		Prototype 3	
Company of KE	Coach	Company of KE	Coach
CCI	SAP	CCI	SAP
CNM	SAP	CNM	SAP
EADS	EADS/KC	EADS	FBK
ISN	KC	ISN	KC

Table 1 – Application Partner/Coach assignment for the modelling activities within APOSDLE

Whereas in the case of CNM the knowledge engineers were domain experts themselves, in all other domains (ISN, CCI, EADS), the knowledge engineers and the domain experts were different (groups of) persons.

5.2.1 Phase 0. Scope and Boundaries

Even though all KEs (CCI, ISN, EADS, CNM) stated that it was clear what should be achieved during this phase, for P2 the main problem was a lack of understanding of how a model should look like (KE: CCI, EADS), what was an adequate APOSLDE domain (KE: ISN, Coach: KC) and how the models would be used in APOSDLE (KE: CCI). Nonetheless, knowledge elicitation techniques (questionnaire) and modelling methods (process and domain scribble) of P2 were seen as useful (1 KE, ISN).

Due to their experiences from P2, for P3 the KEs had a good understanding of what was an appropriate domain for APOSDLE. All of the KEs gave an explanation why they had selected a certain APOSDLE domain for P3. Most of these explanations were based on the questions from the initial questionnaire applied in this phase.

The results points to the necessity of good examples both for adequate domains and for "good models". They also point to the necessity of having at least a basic understanding of the target system in which models are going to be used, in this case APOSDLE: This was the motivation to systematically develop a questionnaire (the initial questionnaire described in Phase 0) accompanied by guidelines on how different situations will potentially affect the performance and usefulness of the APOSDLE system. We see the initial questionnaire as a useful means for identifying an adequate APOSDLE domain.

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For P2, most of the KEs expressed difficulties in finding adequate documents for several reasons, e.g. they stated that knowledge of the domain was not documented (KE: EADS), no documents were available which could be used for learning and teaching (KE: CCI), documents were not centrally stored (KE: CCI, EADS), no workflow descriptions were available (KE: CCI), etc. Despite these problems, “In the end, knowledge engineers found more resources than they had expected” (Coach: KC).

In the initial questionnaire used in P3, no more difficulties in this phase were mentioned by the KEs and coaches. On the contrary, the same KE (CCI) who had expressed great difficulties when collecting documents for P2 stated that “It was easy to find crucial documents” in P3. At this point the question remains if this is due to the methodology, the experience of the KEs or due to addressing another domain with more documents. In any case it can be assumed that the KEs did not report any more problems for this phase because they knew that they would find documents, and they knew what to look for.

Even though the Scope & Boundaries phase was described to be generally difficult (for P2 and P3) by most KEs and coaches, nevertheless it was seen by them as a positive experience: All stated that as a positive side-effect, the company thinks about implicit knowledge and implicit processes in the company in a structured manner (P2: EADS, CCI; P3: ISN, SAP) which would not have been the case without modelling their domains for APOSDLE.

5.2.2 Phase 1. Knowledge Acquisition

5.2.2.1 Knowledge Acquisition from documents

According to the answers of the respondents of the P2 questionnaires, the objectives of this phase were clear (KE: CCI, ISN; Coaches: SAP, KC). No remarks were made concerning the objectives in this phase for P3 either, so it can be assumed that the objectives were still clear, probably even clearer because the KEs already knew what they needed to model in the subsequent steps.

Both for P2 and for P3, concepts and tasks were extracted from the documents manually (KE: CCI, EADS, ISN). Even though extracting knowledge from documented sources "by hand" was found to be tedious, difficult and very time-consuming (P2, KE: CCI), this way of concept extraction lead to useful concepts according to the KE.

Explanations for the text mining functionalities within the *domain modelling tool* given in P2 during a modelling workshop were clear according to the respondents (KE: ISN, Coach: SAP). One of the KEs (ISN) even stated that written descriptions for using the text mining functionalities would have been sufficient. For P3, an overview of the text mining functionalities was given in the MoKi manual.

The text mining functionalities did not work properly for P2 (KE: ISN). The tool could not be used for other languages than English and it was not able to identify relevant concepts also for English documents (P2, KE: ISN; Coach: KC, SAP). For P2, other tools than the text mining tools provided by the APOSDLE project were used by one of the KEs (EADS). According to this KE (EADS), automatic term extraction was a useful method and efforts should be put into providing more appropriate tools.

For P3, the text mining functionalities were integrated in the MoKi, which was approved by one of the KEs (ISN). As no efforts were put into improving the functionality of the tool, it still did not work properly for P3, which was pointed out by only one of the KE (ISN). From this fact we may conclude that the tool was not tried out by the other KEs because of their experiences during modelling P2. As term extraction by hand seems tedious and time consuming, for future versions of the modelling methodology it might be worthwhile considering to put effort into the improvement of the text mining functionalities.

5.2.2.2 Knowledge Acquisition from Experts

In this phase, when eliciting knowledge for P2, the objectives were clear for the KEs (KE: CCI, ISN; Coach: SAP). According to the KEs, the explanations were clear for them (ISN, CCI, CNM), but would not have been clear for a person not experienced in knowledge engineering (KE: CCI, CNM). It was

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difficult to explain the purpose of modelling, the process and the modelling methodology to people not involved in modelling (EADS, CCI). Moreover, the APOSDLE vocabulary was difficult to understand for people not involved in APOSDLE (KE: EADS). Another general problem stated for both P2 (KE: ISN, EADS, CCI; Coaches: SAP, KC) and for P3 (KE: CCI) is that experts have little time and are not available for knowledge elicitation.

No specific statements were made by the KEs on the clarity of objectives and explanations in this phase for P3. Again it can be assumed that the objectives were clear for them due to their experience from P2. Similarly, when modelling P3, the experts were more interested, because they had a better understanding of the APOSDLE system and the modelling process (KE: CCI). In addition, while knowledge elicitation did not lead to many useful results for P2, in the same domain (CCI) interviews with domain experts were useful for P3 (CCI).

These results point out that for successful knowledge elicitation from domain experts it is indispensable that the functionality of APOSDLE, and the role and importance of the models for the success of the entire APOSDLE system are explained to the experts in a comprehensible manner without using APOSDLE terminology. This is especially important given that the experts have little time in general and are therefore only willing to participate actively in knowledge elicitation if they can see the benefit of their effort.

According to the KEs, this step also requires much effort and time both for the preparation (P2, KE: EADS) as well as for structuring the information elicited from the experts (P3, KE: CCI, ISN). If different experts were involved, they had different perspectives on the domain and it was “difficult to find overlaps” (KE: ISN), i.e. agreement between the experts. In order to facilitate the preparation of modelling efforts, future versions of the modelling method could include templates, checklists and guidelines for the preparation and analysis of different knowledge elicitation techniques (e.g. card sorting).

When modelling P2, some experts had difficulties to think in processes (KE: ISN) and to make implicit knowledge explicit (KE: ISN, CCI). In the case where the knowledge engineers were domain experts themselves (CNM), “the identification of tasks and concepts was easy for the expert”. No such experiences were reported for P3. This might also be related to the fact that the domain experts had a better understanding of the APOSDLE functionality and they therefore had a better understanding of what kind of knowledge they should provide.

Further statements of the KEs in the questionnaires concerned different knowledge elicitation techniques. Knowledge elicitation techniques were adequate according to two KEs (P2, KE: EADS; P3, KE: ISN). Whereas in some domains, card sorting was useful (P2, KE: ISN; Coach: SAP) and card sorting was fun (P2, KE: CCI), it did not lead to many useful results in other domains (P2, KE: CCI, Coach: KC). According to coaches, laddering was effective for the task model (P2, Coach: SAP) and for the domain model (P2, Coach: KC). For modelling P3, a modified version of card sorting (Section 3.3.3.5) was applied in three domains (KE: ISN, EADS; Coach: SAP), which was found to be very useful.

These results indicate that different knowledge elicitation techniques are useful in some situations, why they are not in others, and that there are personal preferences of domain experts (e.g. some like card sorting, some do not) which need to be taken into account when preparing a knowledge elicitation session.

5.2.3 Phase 2. Modelling of domain and tasks

Both for P2 and for P3 the objectives of the phase were clear according to the KEs and coaches (P2, KE: ISN, EADS, CCI; Coach: KC; P3, KE: EADS, Coach: FBK). However, at this modelling stage in P2, the KEs still had problems to understand how the models would be used in APOSDLE (KE: EADS).

While the explanations of what to do also were clear according to the KE (P2, KE: ISN; P3, KE: EADS), in P2, modelling rules for the semantic MediaWiki (P2) were not clearly specified (KE: EADS), Furthermore, it was not clear how to handle the P2 Wiki (KE: CCI) and a manual was lacking (KE:

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CNM). More specifically, the problems of the semantic MediaWiki from P2 mentioned by the respondents were that it was unclear how to model relationships between concepts (KE: CCI, ISN) and that it was difficult to find the functionality for renaming tasks and concepts (Coach: KC). The main problem at this stage for P2 was the change of the Wiki to a semantic MediaWiki which caused additional effort for the KEs (KE: CCI, CNM, ISN; Coach: SAP). In two domains, the semantic MediaWiki was considered cumbersome for modelling concepts and tasks (CCI, CNM), whereas the KEs from the other two domains found it functional (ISN, EADS).

Further comments on the semantic MediaWiki of P2 were that the models of different domains should be in separate Wikis (KE: EADS), and that the functionality of the Wiki needed to be improved in general (KE: EADS). Another problem stated by one of the KEs (EADS) was that the semantic MediaWiki did not support the iterative modelling process.

Based on the answers in the questionnaires for P2, the semantic MediaWiki was replaced by the MoKi (see Section 4.2). The MoKi was considered to be effective and convenient by all respondents of P3's questionnaires. According to them, the user manual was good (KE: EADS), the import functionality was helpful (KE: EADS), the different visualizations of the domain concepts and tasks allowed for getting an overview over the models (KE: CCI, EADS) and the MoKi supported the involvement of domain experts (Coach: FBK). Minor problems reported in the questionnaires were that a description of how to use the "is part of" relation in the MoKi was missing (KE: CCI; Coach: SAP) and that deleted concepts were still visible in the MoKi (EADS). One positive remark was made on the fact that there was a separate MoKi for each partner (KE: EADS). None of the negative remarks from the questionnaires in P2 was made for the MoKi. We conclude from these results that the MoKi is a useful tool for (informal) modelling.

For modelling P2, in order to enable a review of the models by all coaches and in order to facilitate collaborative modelling, the models were built in two languages (national language plus English) which was found to be very tedious by the KEs (KE: CCI). In P3, models were only built in one language.

Because of APOSDLE-specific requirements, in the modelling method for P2, the informal task model had to be transcribed into a YAWL model manually (by SAP). The YAWL model was then converted automatically into owl-files. The informal P2 domain model in the semantic MediaWiki was automatically exported into owl-files. Then, if desired, the formal task and domain model could be manually edited.

The analysis of the evaluation questionnaires for P2 showed that YAWL and Protegé were considered as appropriate tools for formal modelling (KE: ISN, CCI, CNM; Coach: KC). Minor technical problems with Protegé were reported by one of the KEs (CCI). One coach (KC) also stated that formal models were well prepared by the technical partners (FBK and SAP). However, the transformation from the informal task model in the Wiki was time consuming and an automatic translation from the Wiki to YAWL would have been helpful (Coach: SAP). According to one KE (ISN), some relations got lost during the transformation of the domain model from the Wiki to an owl-file. Even though the explanations how to handle the formal models seemed clear, results in this stage of P2 were partly wrong according to one coach (SAP).

For P3, the export from the Moki into owl-files was further improved. Formal task and domain models were generated automatically without additional effort, neither for the KEs nor for the coaches, which was mentioned positively in the evaluation questionnaires (KE: ISN, EADS; Coaches: FBK, SAP). The fact that, once the informal model is in the MoKi, no additional effort is necessary to create formal task and domain models, constitutes in our view a great improvement of the modelling methodology.

After modelling P2, different opinions existed on the necessity of the informal modelling stage, i.e. of modelling tasks and topics in the semantic MediaWiki before they are translated into formal models. Some of the KE found informal modelling not necessary and would have preferred to directly start with formal modelling (KE: CCI). Others found that it was essential to start from informal modelling before creating formal models (KE: EADS; Coach: SAP). No such statements were made for P3. One explanation might be that informal modelling was much easier for P3 than it was for P2 and that models had to be provided only in one language. In addition, unlike for P2 where the task model had to be created manually from what was written in the semantic MediaWiki, the informal domain and

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task models of P3 were translated into formal models in a fully automatic way. This way, modelling efforts were not duplicated anymore and fewer tools were used, which was seen as beneficial (Coach: SAP). Consequently it might have been the case that the benefits of informal modelling were more obvious in the MoKi than they had been in the semantic Media Wiki from P2.

A few more conceptual issues came up during the evaluation. Two KEs stated that it was difficult to find labels for domain concepts (P2, KE: EADS, CCI). Another issue stated by the KEs was the question of granularity: for the KEs it was hard to decide if a model has the "right" granularity (P2, KE: ISN, CCI). Even though these two issues were only brought up for P2, we assume that the questions of the right granularity and the right labels for concepts are general ones which were also present when modelling P3. We believe that the reason why the problems were not stated for P3 was that the experts had already experience both with modelling and with APOSDLE and they therefore had a better feeling for what is the right granularity of the models and what are good labels for concepts in APOSDLE. However, the question what is the right granularity and what are the right labels for concepts cannot be answered in general. Different factors need to be taken into account, such as the resources (documents) available, or the target group of people who should learn with the APOSDLE instance.

For modelling P3, two KEs (CCI, ISN) reported that they used MS Visio to build graphical domain and task models which both found very helpful for the subsequent steps. It is worth considering that a sub-step is added in this phase for graphical modelling of the domain and tasks.

Both the semantic MediaWiki (P2) and the Moki (P3) were not used in a collaborative manner among the KEs of different domains (P2, KE: CCI, ISN; Coach: KC; P3, KE: EADS). Nonetheless, the Wiki and Moki were used in a collaborative manner by the knowledge engineers and their coaches, which was found to be very convenient (P2, Coaches: SAP, KC; P3, FBK).

5.2.4 Phase 2a. Validation and Revision of Domain + Tasks

The objectives of this phase were clear to the KEs for P2 (KE: ISN, CCI, EADS) and for P3 (KE: EADS; Coach: FBK). Some KEs also stated that the explanations were clear (P2, KE: ISN; P3, KE: EADS, Coach: FBK), and that the explanations were clear at least for a person being experienced in knowledge engineering respectively (P2, KE: CCI).

Even though the KEs had a feeling for what they should do during this phase, it was unclear how model validation should happen for P2 (Coach: KC) because no criteria existed how to validate the informal models. In addition, it is hard to say when an informal model is finished (Coach: SAP). For P2, the KEs stated that it was not possible to assess the quality of the model without the help of a coach or someone else (KE: ISN, CNM). Also, they stated that it was difficult to rate the relevance of single concepts (KE: CCI, EADS) and that a graphical representation of the models was missing for P2 (KE: EADS; Coach: SAP). It seemed that the semantic MediaWiki of P2 did not support the validation of the task and domain model very well. Getting an overview of the model was difficult in the Wiki (Coaches: SAP, KC). Indeed with the Wiki it was possible to extract relations between concepts so that a revision by domain experts could be done, but it was difficult to extract relation pages (KE: ISN). According to one of the coaches (KC), revision of P2 was only made from a formal perspective but not from a content perspective.

For P3, we tried to facilitate this modelling step by providing a better overview of the models in the MoKi, and by preparing guidelines for manual and automated model checks as well as an ontology questionnaire. One of the KEs (EADS) stated that the ontology questionnaire was not used, but no negative statement was made with respect to the ontology questionnaire. According to the KEs the MoKi, especially the "is a" and "part of" browsers, helped validation and revision (KE: CCI, EADS; Coach: FBK). The formal check report from the automated model checks was very long (KE: ISN) but gave a nice overview (KE: ISN, EADS; Coach: FBK). From these statements we conclude that the support for model revision at this stage basically is useful, but further effort is needed for improving them, for instance by changing the presentation format of the automated check report.

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As for knowledge elicitation, experts were also involved in this step. Again, for P2, the KEs were facing the problems that experts had very little time and were not available for model revision (CCI, EADS), and that they were not interested in it (KE: CCI; Coach: KC). Nothing was stated about the availability of experts in this modelling step for P3. It can be assumed that the availability of experts is always a critical issue. We interpret the absence of negative statements as an indicator that (a) the experts were more interested in model revision because they had more knowledge about APOSDLE and the role of models and (b) the validation tools provided made it easier for the KEs and experts to check their task and domain models.

5.2.5 Phase 3. Modelling of learning goals

For the phase of modelling learning goals, we were facing the same situation as for the previous steps: while the objectives of this phase were clear (P2, KE: ISN; P3, KE: EADS) and also the explanations were understandable (P2, KE: ISN; P3, KE: EADS), modelling learning goals in P2 was still perceived as difficult because of a lack of understanding about the role of models in APOSDLE.

Both versions of the TACT tool were easy to implement and use (P2, KE: ISN, CCI, CNM, EADS; P3, EADS, ISN, CCI; Coach: SAP) with minor usability issues (P2, KE: ISN; P3, KE: ISN), minor technical problems (P2, CCI) and suggestions for improvement were given (P2, KE: EADS; P3, KE: EADS), like for instance that learning goals for sub-concepts should be inherited from learning goals for high-level concepts (CCI).

When modelling learning goals for P2, learning goal types (previously called competency types) were unclear in some situations (KE: CCI). For the P3 version of the TACT, descriptions of inheritance mechanisms in the TACT were missing (KE: CCI). In all, these results indicate that the TACT generally fulfilled its purpose. Suggestions for improvement should be considered in future versions of the tool.

For modelling P3, the concept of variables was introduced. Some KEs used variables to reduce the modelling effort (KE: ISN, Coach: KC), others avoided them in order to keep the models simple (KE: CCI, Coach: SAP). The KEs found it was easy to understand how to use variables (KE: ISN), and to insert them in the MoKi (KE: ISN, EADS, Coach: FBK) and in the TACT (KE: ISN). According to one KE (ISN), the best procedure is to insert variables in the MoKi and get them as hints in the TACT. One difficulty reported about variables was that it was difficult to understand how variables would be used in APOSDLE (KE: EADS). This again points to the necessity of making the functions of APOSDLE more transparent for the people involved in modelling.

A possible problem that occurred when using variables for learning goal modelling is that the number of tasks in the model is drastically increased (Coach: KC). It is hard to say by now, if this is really a problem. This is something which needs to be investigated during the overall evaluation of APOSDLE.

5.2.6 Phase 3a. Validation and Revision of Learning Goals

For P2, this step was performed after the evaluation questionnaires were given to the KEs and Coaches. Thus, no results exist for this phase. The only statement for this phase in P2 was that it is hard to say when a formal model is finished (Coach: KC).

According to one KE (EADS), the objectives and explanations of this phase were clear. No further statements were made by the respondents on the clarity of objectives and explanations in this phase, which we take as an indicator that there were no major problems in this phase.

The check report was found to be helpful and to give a nice overview over the models (KE: ISN, EADS; Coach: FBK) even though it was very long (KE: ISN). Another KE (EADS) stated that the result of the check report rather concerned the technology partners than the KEs. From these results we conclude that effort needs to be put into the format of the check report and that further effort should be put into the explanation of the results to the KEs.

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One of the KEs (ISN) stated that the Excel sheet produced by the TACT was very useful for checking the learning goal model. Exploiting the output of the TACT as a model validation method could be worth considering for further improving the modelling method at this stage.

5.2.7 General remarks

General remarks for P2 were made on the fact that modelling efforts could not be estimated (KE: CCI, ISN) and that the organization of the modelling process was not clear (KE: CNM). In addition, in general there was a lack of understanding of the role of models in APOSDLE (Coach: SAP). No remarks were made concerning these general issues for P3. This might be due to the fact that the KEs already had experience with the modelling methodology, that they could estimate the modelling effort and that the organisation was therefore clear. Nonetheless, this is an important point when starting the modelling process in a new learning domain: The role of the models, the modelling process and the modelling efforts need to be clarified in advance in order to allow for a successful creation of models.

For P2 it was stated that the KEs had difficulties with knowledge engineering because they had no experience with it (KE: CCI). Also for P3 it was stated that modelling cannot be done by people who have no experience in knowledge engineering (KE: CCI, ISN; Coach: SAP). A decision needs to be made whether it is intended that modelling can also be done by persons who have no experience in knowledge engineering. If this is the case, means and measures should be thought of, which introduce people not experienced in knowledge engineering with the very basic ideas and principles (e.g., what is an ontology, what is a model, why is a model needed) at the very beginning of the modelling process.

Another point that was mentioned in the evaluation questionnaires was the complexity of the model. One KE (EADS) stated both in the P2 and in the P3 questionnaire that the model does not allow to depict the inherent complexity of the domain, for instance in their domain one and the same process step would be performed several times in the process and would require different skills each time. On the other hand, the model of P2 was found to be too complex by another KE (CCI). For P3 it was kept simple (e.g. they were not using variables) and therefore it was easily manageable (KE: CCI; Coach: SAP). The complexity of domains which can be realised within APOSDLE should be discussed during the scope and boundaries phase in order to make sure that APOSDLE is the right system to support learning in that domain.

One of the statements in the questionnaire was referring the number of modelling tools involved. Even though the number of tools was already reduced for modelling P3 in comparison to P2, it would be nice to have everything in one tool (KE: ISN). Another point related to this is the fact that changing the model (e.g. the label of a task) once the learning goal model is finished is still difficult and has to be done manually (KE: ISN). Future work could be dedicated to integrate even more the different modelling tools, with the long-term goal to have only one modelling tool where the KEs can flexibly move back and forth between informal and formal task, domain and learning goal modelling.

According to the statements of one of the KEs for P3, the modelling process is still time-consuming and speeding up the modelling process is seen as crucial for the success of a real-world application (KE: CCI). The coach of this KE (SAP) agreed that modelling was time consuming but regarded the time to be invested in modelling as “acceptable” for a real world application. No remarks were made by the KEs and coaches of the other domains for P3. Table 2 shows the estimated modelling effort in hours of each KE for P2 and P3.

KE	**CCI**		**EADS**		**ISN**	
Coach	SAP	SAP	KC	FBK	KC	KC
Prototype	P2	P3	P2	P3	P2	P3

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Scope & Boundaries and Resources Collection	280	80	24	40	45	70
Knowledge elicitation from Digital Resources	140	60	80	0	30	16
Knowledge elicitation from Domain Experts	100	50	40	0	30	140
Modelling of domain and task (Semantic Wiki)	300	20	120	8	90	25
Validation and Revision I	60	10	24	2	12	16
Modelling of domain and task (Protegé and YAWL)	25	0	1	0	0	0
Modelling of learning goals (TACT)	16	80	8	8	3	20
Validation and Revision II	N/A	4	N/A	1	N/A	8
Total (hours)	921	304	297	59	210	295

Table 2 – Comparison of modelling efforts (in hours) for each phase in P2 and P3 as estimated by the knowledge engineers.

Looking at the table, one has to bear in mind that CCI was modelling from scratch for P3 and that only a third of the time was needed though, which indicates that modelling was easier for the KE when modelling P3, which is probably due to (a) the experience in modelling, (b) the knowledge about APOSDLE and the role of models in APOSDLE (c) the improvement of the modelling tools and (d) the reduction of complexity in the model as compared with their models from P2 and (e) the selection of a more appropriate ("simpler") domain, which was easier to model. Moreover, also due to the scope and boundaries questionnaire, the domain fit better with the application scenario of APOSDLE (the P3 domain was more task driven than the P2 domain).

The numbers in the table are mentioned here to give an approximate impression about the time needed for modelling. However, modelling time cannot be directly compared for different models as the effort needed depends on a variety of factors, such as the

- Scope of the domain (Number of concepts, tasks, learning goals)
- Access to relevant documents
- Availability of process descriptions or concept hierarchies
- Availability of experts for knowledge elicitation and model validation
- Complexity of the model (hierarchical depth of domain model, usage of variables…)

As mentioned above, further improvement of the efficiency of the modelling methodology could be planned, e.g. by reducing the number of tools involved. Having everything in one tool should already speed up the modelling process. However, other facilities have to be invented which help in reducing the modelling effort for the KEs at every stage in the modelling process.

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6 Conclusions

In this document we described the second version of the APOSDLE Integrated Modelling Methodology. This methodology, developed within the APOSDLE project, guides the process of creating the application domain dependent parts of the APOSDLE Knowledge Base. The APOSDLE Knowledge Base provides the basis for reasoning within the APOSDLE System.

We provided a description of the approach taken in order to produce the second version of the Methodology and of the main differences between the two versions, a detailed overview of the phases of the methodology and of the tools used to support it. Finally we provided an overview of the feedback obtained from the evaluation of the modelling activities and an in-depth comparison between the first and second version. The feedback collected from Application Partners and coaches, who have accurately followed the second version of the Methodology during the development of Prototype 3 provide the basis of future enhancements of Integrated Modelling Methodology and tools to be used for in further developments of the APOSDLE system.

As was illustrated in Section 5, the main results coming from the application of the Integrated Modelling Methodology – second version, show a considerable improvement when compared with the results obtained with the first version. They also highlight specific points where improvements are needed.

One of the main results of the refinements of the Integrated Modelling Methodology is that it has allowed to instantiate even further the general task of “modelling” in the APSODLE context, and to build the modelling phases which are needed to create an operational APOSDLE system. Additional positive results are:

- An increased awareness of the aim of modelling and of the modelling process within APOSDLE. Precise reasons for this increased awareness are difficult to provide. They can be partly due to the restructuring and simplification of the IMM, and to the improved guidelines, manuals and guidance provided in this second version, as well as to the fact that the KEs already had experience with the modelling activities performed for the 2nd Prototype. Nonetheless, this is an important point when starting the modelling process in a new learning domain: The role of the models, the modelling process and the modelling efforts need to be clarified in advance in order to allow for a successful creation of models.
- A reduction of the “granularity issue”. Finding the “right” granularity level at which a domain has to be described is a general modelling issue which goes beyond the scope of APSODLE. Nevertheless, the integrated modelling approach taken for the IMM – second version, appears to have simplified the task of developing a coherent and integrated ASPODLE knowledge base, thus reducing complaints about the “right granularity” of modelling.
- A positive evaluation of the tools. The evaluation of the tools developed to support the IMM was generally positive. In particular, the improved version of the MoKi has helped to remove all the comments on the usage of Semantic Wiki’s, which were part of the evaluation of the IMM – first version. The reports obtained from the validation tools helped a focused and quick revision of the models, thus speeding up the modelling process.

The main item where improvement is still required is to decrease, as much as possible, the effort of modelling and build, at the same time, good models for the APOSDLE system. Easing the task of modelling is a general problem in building knowledge dependent systems which goes beyond the scope of APOSDLE. Nevertheless, the evaluation of the IMM – second version has shown that the redesign of the methodology and of the tools was a fist good step in this direction. It has also highlighted further improvements which could contribute to make modelling mode effective and which can provide the basis for further improvements of the modelling tools. Among the most important are:

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- To integrate all the tools and routines in a single modelling tool. A re-engineering of the MoKi to include all the different modelling tools in one too would further reduce the modelling effort by simplifying and speeding up the construction of the APOSDLE knowledge base.
- To improve the task of knowledge extraction by providing better automatic knowledge elicitation from digital resources and by embedding state of the art knowledge elicitation tools in the MoKi.
- To train expert coaches in order to guide the Application Partners in the application of the IMM.

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7 Appendix 1: The Meta-Model of the APOSDLE Knowledge Base

The main elements of the meta-model are the elements of the different models and data structures, with particular focus on their mutual relationships, as illustrated in Figure 15.

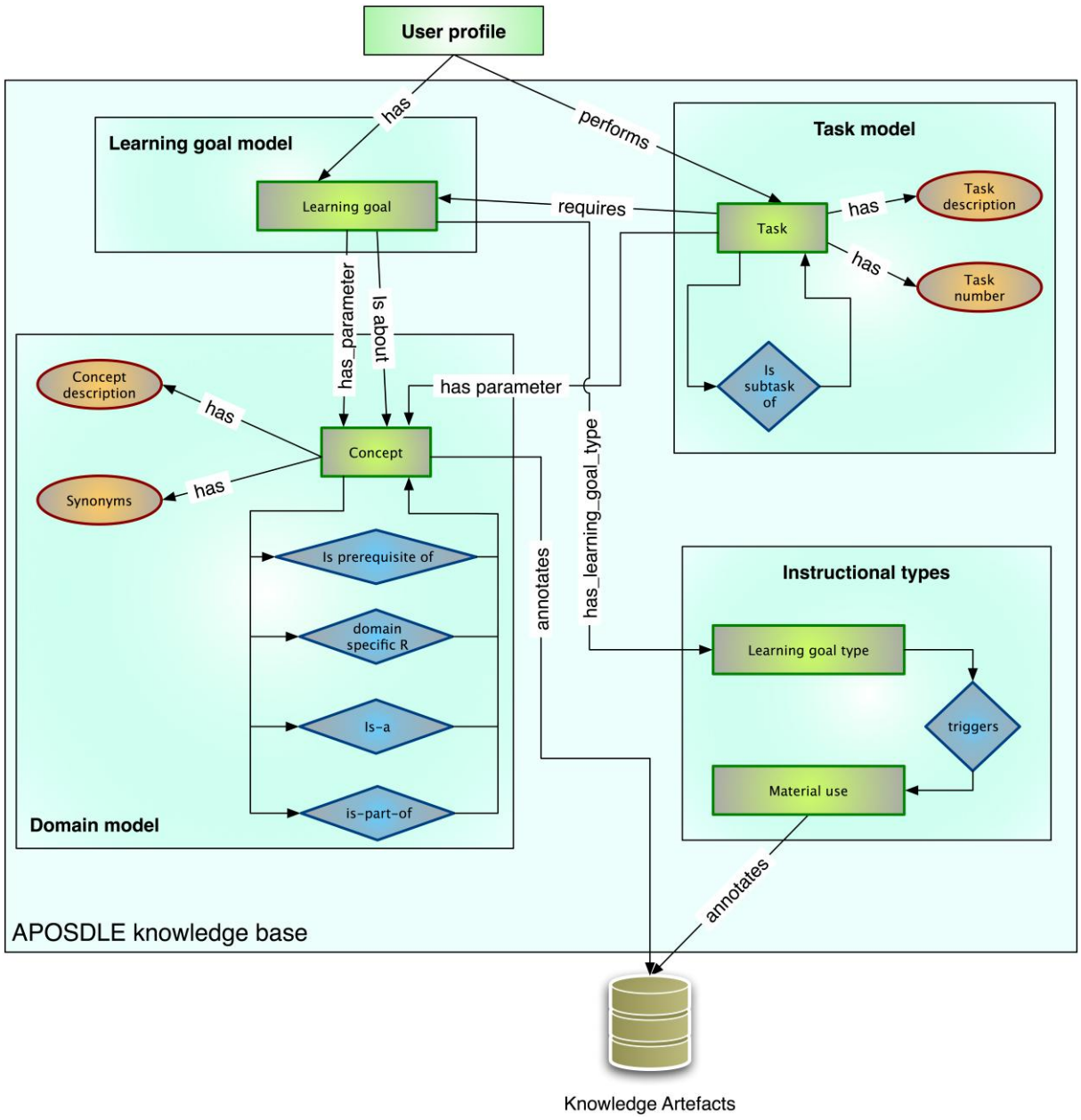

Figure 15 – The meta-model of the APOSDLE knowledge base.

The main elements of the APOSDLE Knowledge Base meta-model are:

1. the Domain model;
2. the Task model;

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3. the Learning goal model;
4. the APOSDLE instructional types;
5. the relations between all the elements above.

In this section we describe these elements and their relations in detail.

7.1 Domain Model

The domain model contains the vocabulary and description of the business (learning) domain modelled in the APOSDLE knowledge base. It is formalised as an OWL ontology.

The main elements of the domain model are **concept** elements. Each concept has two attributes: "**concept description**" and "**synonyms**". These are used to store the textual description and a list of synonyms of the concept itself. The values of "concept description", and "synonyms" are provided at modelling time by the modellers / domain experts.

The **Is-a** and **part-of** relations are used with their standard meanings. Namely they are used to structure concepts in a hierarchy of sub-concepts and to represent the components of a concept respectively.

In addition to concepts the domain model can also contain domain specific **relations** that are used to "connect" different concepts. That is a domain specific relation, say R, can be used to specify that concept A is in relation R with concept B.

Domain concepts can be related via the **is_prerequisite_of** relation. This relation is meant to identify prerequisite concepts for learning. It is not modelled by domain experts at modelling time but is computed on demand after assigning learning goals to tasks. The modellers can remove the automatically created prerequisite relationships during or after the task-learning goal mapping done using the TACT tool.

7.2 Task Model

The task model contains a structured list of tasks, which refer to a certain business. The goal of the task model is to contain a description of tasks and possibly of the decomposition of tasks in their components. Differently from the meta-model used for the development of the 2nd prototype, it only contains some information to retrieve the graphical ordering of sub-tasks within a process but not the workflow information about processes. Concerning this change we must stress that the task models, as considered in APOSDLE, are not comparable with ordinary workflow models. In fact the APOSDLE system provides documents/templates for the current working step to help the user in performing/learning the current task. Therefore, each task or sub-task is assigned with several documents that contain learning content for the current work step. Here, the user is not restricted to a specific task order. The system allows the user to move freely between the different tasks and sub-tasks. Therefore, a deep modelling of temporal task orders will result in additional effort though not being considered in the running APOSDLE except by the task viewer. For this reason we decided to adopt the OWL ontology language also for the formalisation of tasks and not the YAWL workflow language.

Each task has an attribute "**task description**" used to store the textual description of the task. The values of "task description" is provided at modelling time by the modellers / domain experts.

The ordering of tasks in a process (graph) is stored according to some "intelligent numbering" on the basis of the graphical representation of the task. To store the intelligent number of a task, an attribute "**task_number**" is used. An in depth description of task numbers is contained in Section 7.2.1.

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Task names can contain at most one "**parameter**". This parameter is a concept from the domain ontology. We refer to tasks with parameters as "abstract tasks" and tasks without parameter as "ground tasks". An in depth description of the use parameters with tasks is contained in Section 7.2.2.

Tasks are decomposed in sub-tasks. The relation "**is-subtask-of**" is used to express the hierarchy of sub-tasks. **is-subtask-of** is formalised as a "part-of" relation.

In the informal modelling phase a task is associated to some "**knowledge required**" (under the form of domain concept), but this relation is not stored in the formal model (and thus not formalised in the meta-model). The knowledge required information is used in TACT to help with the definition of learning goals.

7.2.1 Task numbering to model a workflow ordering

The investigation of the task models for prototype 2 revealed, that workflow constructs as for exampled used in YAWL seem to be over-expressive for our purposes. For APOSDLE prototype 3 exclusively constructs were allowed, which do not distinguish between parallelism, logical AND and logical OR (to keep the models simple for domain experts): hence, an extension of the task model by an attribute TaskID is sufficient to model the temporal relationship between the tasks as we explain in the following.

In a nutshell, we create task models that briefly give an overview of the overall process. AND, OR and parallelism constructs are not distinguished, i.e. are treated with the same modelling construct. Additionally, the task model should be expressive enough to define task-subtask relationships. We suggest that a numbering attribute will be specified add the end of this modelling phase. The following example shows how the numbering works and fulfils the requirements as summarized before.

This could be a sample task model how application partners would define it in the first phase of the informal modelling (e.g. in Visio).

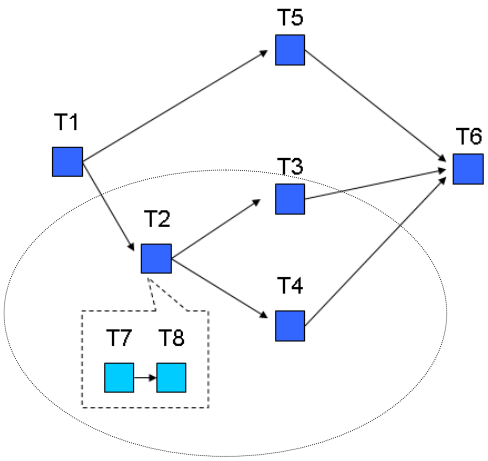

Figure 16 – An example of task model

The example task model consists of eight tasks starting with T1 and ending with T8. There is an OR split from T1 into T5 and T2-T3-T4. Note that T7 and T8 are subtasks of T2. The basic rules for the numbering are that:

- sequences are expressed by sequenced numbers (e.g. "2 " following "1");
- AND, OR and parallelism are expressed by using the same number plus a suffix, i.e. "2a" and "2b" would be parallel or alternative tasks;
- subtasks are specified by using a dot-notation, i.e. "1.1" would be a subtask of "1".

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Already this simple example illustrates pitfalls that have to be considered during the task numbering process. Obviously, T1.number = 1. Since T5 and T2 are separated by an OR-split, we could assign both tasks a number 2 as follows: T5.number = 2 and T2.number = 2 (parallel to T5). T3 and T4 follow T2. Therefore, a logical consequence would be that T3.number = 3 (after T2) and T4.number = 3 (after T2, parallel to T3). Obviously, this order leads to a conflict: T3 follows T2 (number = 2), but is still parallel to T5 (number = 2) which is not expressed using this way of numbering. Introducing an abstract task (see dashed oval in the following figure), we can easily solve this conflict. T1 is still the first task (T1.number = 1). Since T5 is parallel to T2-T3-T4, we introduce an abstract task including the three latter tasks. Note that in the following, letters are used to indicate splits in the task model. Sub-Tasks are indicated by different number levels separated by a ".".Following numbering is a result of this approach:

- T5.number = 2a
- T2.number = 2b.1 (parallel to T5)
- T7.number = 2b.1.1
- T8.number = 2b.1.2
- T3.number = 2b.2a (after T2, parallel to T5)
- T4.number = 2b.2b (after T2, parallel to T3, parallel to T5)
- T6.number = 3.

In this case, 2b would be the abstract task that not necessarily has to be specified by the application partners. Cleary, all temporal relations are expressed using this numbering.

We introduced this numbering scheme as the attribute “task_number” (property of type String) in the meta-model.

7.2.2 Modelling tasks with parameters

The result of the modelling activities of P2 revealed the need for a better bundling of tasks, which repeat their structure in different parts of the domain. We will now show and discuss such a bundling mechanism called *task parametrisation.*

Consider the following examples of tasks extracted from the P2 task models of CCI and ISN respectively:

- sketch solution;
- create agenda.

Both tasks do not define a precise activity: in the first task the consultant of CCI executing that task will probably work to sketch a solution for a certain <issue>, while in the second task the person from ISN will work to create an agenda for a certain <activity> (e.g. a workshop, a conference, a meeting and so on). Depending on the <issue> to be solved or the <activity> for which the agenda is being prepared, the worker using APSODLE may need to achieve different learning goals. Thus, the modelling of tasks at a general level as in the examples above constitutes a problem for ASPODLE as tasks are disconnected from the domain knowledge or the problem-solving knowledge necessary to support the workers in their actual and concrete activities. On the other hand forcing the domain experts to model activities at a very specific level would make the modelling of tasks cumbersome and not very natural. To address this problem we have introduced the notion of **parameter**. The main idea is to use the knowledge present in the domain model to support a detailed specification of tasks in a compact manner. Thus we stimulated the domain experts to evaluate if their tasks could be extended by introducing a concept from the domain ontology, for instance by changing “create agenda” to “create agenda for <activity>”. Notationally we use <A> to denote a parameter in a task.

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The intuitive semantics of a task with a parameter is the class of tasks obtained by replacing the parameter with all the sub-concepts (according to the is-a relation) of the concept used as parameter in the task name, including the parameter name itself.

Example 1: The task “Prepare agenda for <activity>” contains the parameter “activity”.

The domain ontology contains the following taxonomic information (indentation is used to graphically represent the is-a relation)

activity

meeting

board meeting

demo meeting

workshop

Then from the task “Prepare agenda for <activity>” we obtain the following tasks, also ordered in **is-a** hierarchy

Prepare agenda for activity

Prepare agenda for meeting

Prepare agenda for board meeting

Prepare agenda for demo meeting

Prepare agenda for workshop

Task parametrisation is introduced to allow the modelling of tasks in a compact manner (i.e., without forcing the specification of a number of very similar tasks) but at the same time to obtain information in the models about the real tasks that users are doing at “run-time”. In this way, APOSDLE users will obtain information about specific tasks that they need in realistic learning situations. For example, the modeller creates the task “Prepare agenda for <activity>”, and assigns general learning goals to the task (e.g. “basic knowledge about: <activity>”). Then s/he indicates that there are different “activities” (i.e. “activity” is a parameter), and that for each of the specific activities, the user needs to have “profound understanding of” the respective activity (i.e. the knowledge engineer defines the learning goal parameter).

Note: Abstract tasks may trigger some reordering of the domain ontology as the more specific tasks are obtained using the is-a hierarchy of domain concepts and should be used only if strictly necessary.

7.2.2.1 Ground tasks, abstract tasks, and specialised tasks

In order to deal with parameters, different types of tasks have to be defined. Normal tasks without parameters are “ground tasks”. Tasks with parameters are called “abstract tasks” and tasks created from tasks with parameters are “specialised tasks”.

Ground task: A ground task is a task without a parameter. For example “Prepare Agenda for Activity” is a specialised task.

Abstract task: An abstract task is a task with a parameter that is about a certain topic (such as “Activity”) with sub-topics in the domain model. Parameters are denoted using “< >”. For instance, the task “Prepare Agenda for <Activity>” is an abstract task that contains the parameter <Activity>.

Specialised task: A specialised task is the instance of an abstract task. An abstract task is de-composed into specialised tasks by replacing the parameter with all sub-topics of the topic that the parameter is about.

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7.3 Learning Goal Model

We regard a learning goal as the combination of learning goal type and domain concept. Each learning goal is defined as a pair <learning goal type, domain concept>, which are retrieved by means of the "**has_learning_goal_type**" and "**is_about**" relations in Figure 15. For a list of learning goal types see Section 7.4.1. The domain concept defines the content that the learning goal is about. The learning goal type specifies the type (or somehow the "degree") of knowledge (and skills) the person needs to have about this topic for performing a specific task.

For instance, a learning goal "basic knowledge about: APOSDLE Wiki" would describe the ability of a person to read and navigate in the APOSDLE Wiki. The person would know what is available on the APOSDLE Wiki, and how to move back and forth between the pages. The learning goal "basic knowledge about: APOSDLE Wiki" would not include the ability to edit the content of the Wiki, or to insert pages. In order to express the latter, a learning goal "know how to apply/use/do a: APOSDLE Wiki" would have to be defined.

The learning goal model contains the list of learning goals, which refer to a certain business domain and task model. Furthermore, the learning goal model connects tasks to learning goals by means of the "**requires**" relation, which is used to specify which tasks require which learning goals.

7.3.1 Modelling learning goals with parameters

Our modelling experiences have shown that very often the problem arises that a task, in different situations, requires different learning goals. For instance, consider the following example.

Example:

Consider the task "Prepare Agenda for Activity". The topic "Activity" in the domain model has a number of sub-topics (indentation is used to indicate the sub-class hierarchy):

Activity

> Meeting
> Board Meeting
> Demo Meeting
> Workshop

It is quite difficult to assign learning goals to the task "Prepare Agenda for Activity". For instance, preparing the agenda for a board meeting might require quite specific knowledge about board meetings (e.g. the learning goal "profound knowledge of: Board Meeting"), whereas it might require no knowledge at all about "Workshop". In contrast, preparing a workshop, of course, might require "profound knowledge of: Workshop", and no knowledge about "Board Meeting". Additionally, there might be knowledge that is required for performing the task "Prepare Agenda for Activity", independent of what is the "Activity", such as "know how to do/use/apply: Agenda".

This small example illustrates the fact that in some cases, tasks are modelled in a way that they might require knowledge independent of the concrete application of the task (e.g. "know how to do/use/apply: Agenda"), and knowledge that is strongly related to the concrete application of the task (e.g. "profound knowledge of: Board Meeting"). This could result in two different modelling decisions:

- **Ambiguous modelling**: a very generic topic is used modelled as a learning goal For instance, the task "Prepare Agenda for Activity" requires the learning goal "basic understanding about: Activity", meaning that in a concrete situation (e.g. for preparing the agenda of a workshop) exactly one specific sub-topic of "Activity" (e.g. "Workshop") is required for performing the task. APOSDLE cannot deal with this ambiguity.

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- **Detailed modelling:** the task is broken down into more specific tasks. For instance, the task “Prepare Agenda for Activity” can be broken down into

  Prepare agenda for Meeting
  Prepare agenda for Board Meeting
  Prepare agenda for Demo Meeting
  Prepare agenda for Workshop

  Then, learning goals are assigned to these more specific tasks. However, this causes extra work for the knowledge engineer, as s/he needs to model all tasks separately, and as s/he needs to assign the knowledge that is always required for preparing the agenda of an activity (e.g. “know how to do/use/apply: Agenda”) to each of these more specific tasks by hand.

The disadvantages of these two ways of modelling can be overcome by using task parameters.

We refer to learning goals (LGS) with parameters as “abstract learning goals” and to learning goals without parameter as ground LGs. A learning goal can contain at most one parameter. This parameter is a concept from the domain ontology. The semantics of a learning goal with a parameter is the class of LGs obtained by replacing the parameter with all the sub-concepts (according to the is-a relation) of the concept used as parameter in the learning goal, including the parameter name itself.

Example: Abstract LG “Basic knowledge about activity” contains the parameter “activity”.

In the domain ontology *activity* has the sub-concepts listed in Example 1. Then from the abstract LG “Basic knowledge about activity” we obtain the following ground LGs ordered in **is-a** hierarchy

Basic knowledge about *activity*
  Basic knowledge about *meeting*
    Basic knowledge about *board meeting*
    Basic knowledge about *demo meeting*
  Basic knowledge about *workshop*

A ground task cannot require an abstract learning goal with a parameter. An abstract task requires exactly one abstract learning goal, and the parameter of the abstract task and the abstract learning goal are the same. The semantics of the “requires” – relation between an abstract task and an abstract learning goal is that for the abstract task “T<X>” such that “T<X> requires LG(lgtype, X)”, each specialised task “T-Y” requires the learning goal lG(lgtype, Y). X is the task parameter, Y is a subclass of X and “LG(lgtype, X)” denotes a learning goal composed of the learning goal type lgtype and the domain concept X. Furthermore, since “T-Y” specialises “T<X>”, it inherits all ground learning goals assigned to T<X>[8].

Example: The abstract task “prepare agenda for *activity*” requires the abstract LG “Basic knowledge about *activity*”. Then we obtain the following pairing between ground tasks and ground LGs:

“Prepare agenda for activity” requires “Basic knowledge about activity”
“Prepare agenda for meeting” requires “Basic knowledge about meeting”
“Prepare agenda for board meeting” requires “Basic knowledge about board meeting”
“Prepare agenda for demo meeting” requires “Basic knowledge about demo meeting”
“Prepare agenda for workshop” requires “Basic knowledge about workshop”

In this way, abstract LGs allow modellers to model LGs and the pairing between tasks and LGs in a compact manner (i.e., without forcing them to specify all the ground LGs and tasks) but at the same time to obtain information in the models about the real tasks and LGs users require at “run-time”.

[8] In OWL, „T-Y“ is a subclass of „T<X>”.

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7.4 Instructional Types

The Instructional Types contain lists of **learning goal types** and **material uses** which are used in the definition of learning goals and in the annotation of documents respectively. The list if learning goal types and material uses is known a priori (ie is not defined at modelling time).

The 1:n relation "**trigger**" is used to describe that a learning goal can trigger specific material uses.

The list of learning goal types in the 3rd prototype is contained in Section 7.4.1. The list of material uses is described in Section 7.4.2.

7.4.1 The learning goal types in the 3rd prototype

The learning goal types used on the 3rd prototype are:

- basic knowledge about;
- profound knowledge of;
- know how to apply/use/do a;
- know how to produce;
- unspecified.

In the following we illustrate each one of them in detail.

7.4.1.1 "Basic knowledge about"

Definition:

The learning goal type "basic knowledge about" means that a worker needs basic knowledge about the topic under consideration, in order to perform the task successfully. Basic knowledge includes the knowledge about dates, names, events, places, prices, titles, major theories.

The learning goal type "basic knowledge about" does not include the ability to use, apply, edit, or transform a topic.

Example

For instance, "basic knowledge about: APOSDLE Wiki" does not include navigating in the Wiki, editing it, or creating links.

APOSDLE use case:

The learner who clicks on the learning goal wants to have basic knowledge about what a <domain element> is.

The knowledge worker has no or very limited knowledge about a topic and wants to have a basic understanding of it, or wants to check whether his basic knowledge is accurate (up-to-date). To reach this goal s/he searches for introductory texts about the topic, definitions, or examples.

Material use types:

introduction, definition, example - what

APOSDLE Examples

- "basic knowledge about: creativity techniques": knowledge about various creativity techniques, and tools available
- "basic knowledge about: addresses": knowledge that a company can have different addresses, knowledge about which different addresses a company can have, knowledge about different addresses of a company

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- “basic knowledge about: REACH interest agents”: basic knowledge about organizations that exert political influence on the implementation of REACH
- “basic knowledge about: exceptions of REACH”: knowledge about substances that are not subject to the regulations of REACH
- “basic knowledge about: model”: knowledge about properties and elements of a various models, knowledge about different types of models required for simulation building

7.4.1.2 “Profound knowledge of”

Definition

The learning goal type “Profound knowledge of” means to comprehend conceptual knowledge about the topic and its properties, and the relationships to other topics in that domain. This includes, for instance, understanding the indication of a certain method, or tool, knowing causes and effects of an error, or understanding the mechanisms of an engine.

Example

If, for instance, this learning goal type is linked to the topic “APOSDLE Wiki”, the learning goal “profound knowledge of: APOSDLE Wiki” means that one understands the structure of the APOSDLE Wiki, the functionality of the icons, or that one is able to navigate in the Wiki.

APOSDLE use case:

The learner wants to have a profound understanding of a <domain element>

The knowledge worker has a basic understanding of a topic, but he still has questions like: OK, I know what it is, but how does this work? Why should I do it (in a certain way)? How did this happen? Why did this happen? S/he searches for explanations that help him to answer these questions.

Or s/he just wants to know more about the topic to be able to understand things s/he reads in documents, or to be able to communicate about the topic with co-workers or to be able to generate new ideas Therefore s/he searches for information that contains backspecialised information, historical data, trends and developments, relationships with other domain elements etc.

Material use types:

explanation, more about

APOSDLE Examples

- “profound knowledge of: scenario techniques”: knowledge about the indication and principles of scenario techniques, understand how scenario techniques work, and why they work that way
- “profound knowledge of: relation”: understand relations within a database system, knowledge about which data are linked to which other data, knowledge about properties of the relations
- “profound knowledge of: REACH substance class”: understand the meaning of the classification of chemical substances in dependence on the date of registration, amount of input, toxicity, environmental compatibility and intended purpose
- “profound knowledge of: domain model”: understand the data model of a certain domain, understand the structure, the purpose of structuring, and the logic of the data model

7.4.1.3 “Know how to apply/use/do a”

Definition

The learning goal type “know how to apply/use/do a” means to carry out procedural knowledge. Therefore, “know how to apply/use/do a” has to be linked only to topics that refer to a set of rules, or

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guidelines (e.g. a computation rule, the UML notation), procedures (e.g. the RESCUE requirements engineering process), a method (e.g, Systematic Interview), or a tool (e.g., Protegé).

“Know how to apply/use/do a” is used, when a procedure/method exists. The learning goal type can be used with methods, formats, applications, calculations, etc.

Example:

If this learning goal type, for instance, is linked to the topic “Card Sorting” (a special knowledge elicitation technique), the learning goal “know how to apply/use/do a: Card Sorting” means to know how to do conduct a Card Sorting session with domain experts, how to prepare Card Sorting sessions, and how to log the results. However, “Know how to apply/use/do a: card sorting” does not mean to know in which situation Card Sorting is indicated, or which are advantages and disadvantages of the technique. Therefore, the learning goal type “Know how to apply/use/do a” does not include “Basic knowledge about” or “Profound knowledge of” a certain topic.

APOSDLE use case:

The learner wants to know how to apply/use/do a <domain element>

The knowledge worker wants to know what the (next) steps are in a procedure or a well defined task that s/he has to perform, but that s/he is not able to carry out without some guidance. S/he searches for information that tells him which steps there are and which order they have to be completed. This information is like a recipe or prescription. Furthermore, s/he likes to have an example or demonstration of the procedure.

Material use types:

how do I, demonstration, checklist, example – how

APOSDLE Examples

- “Know how to apply/use/do a: core learning goal analysis”: ability to perform a core learning goal analysis for a company;
- “Know how to apply/use/do a: Er2”: ability to use the text data format er2 for loading data into another data base system
- “Know how to apply/use/do a: MS Project”: ability to use the specific project management tool for project management, Gantt charts, resource planning, etc.
- “Know how to apply/use/do a: substance fixtures”: ability to perform a survey of chemical substances in use

7.4.1.4 “Know how to produce”

Definition

The learning goal type “Know how to produce” means to be able to create, produce, or build a certain topic, for instance a “task model”. In this sense, “know how to produce” means the ability of a person to achieve a certain outcome without a specified rule or procedure. Therefore, “know how to produce” has to be linked to topics that refer to results (e.g., project report), or products (e.g., build a software).

Example

If this learning goal type is linked to a topic, for instance “Wiki content”, the learning goal “know how to produce: Wiki content” means that a person knows the Wiki setup and notation, and is able to edit the Wiki content. In this case, “profound knowledge of: Wiki content” is a prerequisite of “know how to produce: Wiki content”, and therefore a task that requires the learning goal “know how to produce: Wiki content” would also require the learning goal “profound knowledge of: Wiki content”. However, this is no general rule.

The decision whether the ability to edit the content of the Wiki is specified by the learning goal “know how to produce: Wiki content” or “know how to apply/use/do: APOSDLE Wiki” is on the knowledge

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engineer, and depends on whether there are clear rules or procedures for creating the Wiki (know how to apply/use/do) or not (know how to produce).

APOSDLE use case:

The learner wants to know how to produce a <domain element>

The knowledge worker has to produce something that is not clearly defined but has some constraints (for example: a plan, an agenda for a meeting, a design) and wants to know what he has to keep in mind when performing such a task. He searches for lessons learned by others like guidelines, checklists, templates, examples and/or constraints that give some structure in performing the task without giving a recipe or prescription.

Material use types:

guideline, checklist, template, example – how, constraint

APOSDLE Examples

- "know how to produce: final report": ability to write a final project report for the customer, includes the knowledge of standards and norms for layout, organization, references, etc.
- "know how to produce: scenario": ability to generate simulation scenarios that enable identifying the major entities that must be represented by a simulation
- "know how to produce: REACH material for external consulting": ability to generate documents which the IHK employees can hand on to the costumers during the consulting process

7.4.1.5 "unspecified"

Definition

The learning goal type "unspecified" is used to express that the task under consideration requires all kinds of knowledge about a certain topic.

Example:

For instance, if there is a learning goal that is called "[unspecified:] wiki", a user selecting the learning goal will receive snippets of all types, i.e., examples of wikis, definitions, guidelines, checklists, and all other snippets that are available for the topic.

APOSDLE use case:

The learner wants to receive all snippets that are available for a specific topic.

Material use types:

All material use types

APOSDLE Examples

There are no specific examples – this type can be used for all types of topics

7.4.2 The material uses in the 3rd prototype

The material uses used on the 3rd prototype are:

- Unspecified;
- Introduction;
- Example - what;
- How to;
- Example - how;

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- Definition;
- More about;
- Constraint;
- Checklist;
- Template;
- Demonstration;
- Explanation;
- Guideline.

In addition custom material uses can be added for different learning domains.

7.5 Relations between models.

- A Task "**requires**" learning goals;
- A Task "**has_parameter**" at most one domain concept.
- A learning goal "**has_learning_goal_type**" a certain learning goal type and "**is_about**" a certain domain concept.
- A learning goal "**has_parameter**" at most one domain concept.

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8 Appendix 2: Statements in the Evaluation questionnaires of P2 and P3

8.1 Phase 0. Scope and Boundaries

8.1.1.1 Feedback on the IMM for P2

General

- **"A 2-day workshop is necessary in this phase":** 1 Coach (SAP)

Objectives & Explanations

- **"The objectives of the phase were clear":** 3 KE (CCI, EADS, ISN), 1 Coach (SAP)
- **"The objectives were not clear"** 1 KE (CNM)
- **"The explanations were clear"** 1 KE: ISN
- **"There was a lack of clear understanding how APOSDLE works"**: 1 KE (CCI)
- **"There was a lack of good examples how a model should look like":** 2 KE (CCI, EADS)
- **"There was a lack of good examples of what is an adequate domain":** 1 KE (ISN)
- **"We had no clear criteria which domain is suitable for APOSDLE":** 1 Coach (KC)
- **After the models for P2 were finished there was a better understanding of what is an appropriate APOSDLE domain:** 1 KE (ISN)

Collection of documents

- **"We had difficulties in finding crucial documents"** 1 KE (ISN)
- **"The collection of documents is time-consuming because documents are not centrally stored":** 2 KE (CCI, EADS)
- **"The knowledge about the domain is not documented"**: 1 KE (EADS)
- **"There is no explicit teaching and learning material available":** 1 KE (CCI)
- **"There are no workflow descriptions available":** 1 KE (CCI)
- **"In the end, knowledge engineers found more resources than they had expected":** 1 Coach (KC)

Knowledge elicitation techniques

- **"The knowledge elicitation techniques were adequate":** 1 Coach (SAP)
- **"The process and domain scribble were useful":** 1 KE (ISN)

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8.1.1.2 Feedback both for the IMM of P2 and P3

"As a positive side-effect, the company thinks about implicit knowledge and implicit processes in the company in a structured manner. "

P2: 2 KE (EADS, CCI)

P3: 1 KE (ISN), 1 Coach (SAP)

8.1.1.3 Feedback on the IMM for P3

General

- **"It was challenging to negotiate the APOSDLE domain with different stakeholders":** 1 Coach (KC)

Objectives & Explanations

- **"We knew how domain concepts and tasks have to look like":** 1 KE (CCI)
- **"We knew what was an appropriate domain for APOSDLE":** 1 KE (CCI)
- **An explanation is given why a certain domain was selected:** 3 KE (ISN, CCI, EADS), 1 Coach (KC)
- **"Defining the scope of the APOSDLE domain is still difficult but interesting"**: 1 KE (ISN)

Collection of documents

- **"It was easy to find crucial documents":** 1 KE (CCI)

Knowledge elicitation techniques

- **"The Scope and boundaries questionnaire was useful":** 1 Coach (KC)

Reuse of Models

- **"The P2 model was built the basis for the P3 model":** 1 KE (EADS).
- **"We had no modelling effort because the model already existed"**: 1 Coach (SAP)

Achievement of goals

- **"In our opinion the goals were fulfilled within this step":** 1 KE (CCI)

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8.2 Phase 1: Knowledge Acquisition

8.2.1 Knowledge Acquisition from documents

8.2.1.1 Feedback on the IMM for P2

General

- **"Modelling in this step took a lot of time":** 1 Coach (SAP)

Objectives & Explanations

- **"The objectives of the phase were clear":** 2 KE (CCI, ISN), 2 Coaches (SAP, KC)
- **"Written descriptions for using the term extraction would have been sufficient (Workshop would not have been necessary)"**: 1 KE (ISN)
- **"The explanations were clear"** 1 Coach (SAP)

Knowledge extraction from documents

- **"Extracting knowledge from documented sources "by hand" lead to useful concepts":** 1 KE (CCI)
- **"Extracting knowledge from documented sources "by hand" was tedious and difficult"**: 1 KE (CCI)
- **"Basically, automatic term extraction [with an other tool than the DMT] was a useful method":** 1 KE (EADS)
- **"Efforts should be put into providing more appropriate tools for term-extraction":** 1 KE (EADS)

8.2.1.2 Feedback both for the IMM of P2 and P3

Knowledge extraction from documents

- **"Knowledge from documented sources was extracted "by hand"**:

  P2: 1 KE (CCI)

  P3: 2 KE (EADS, CCI)

- **Term extraction did not work properly**

  P2: 1 KE (ISN), 2 Coaches (KC, SAP)

  P3: 1 KE (ISN)

- **"The domain modelling tool could not be used for other languages than English"**

  P2: 3 KE (ISN, CCI, EADS), 2 Coaches (KC, SAP)

  P3: 1 KE (ISN)

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8.2.1.3 Feedback on the IMM for P3

- **"It is advantageous that the term extractor is integrated into the MoKi":** 1 KE (ISN)

8.2.2 Knowledge Acquisition from Experts

8.2.2.1 Feedback on the IMM for P2

General

- **"APOSDLE vocabulary was difficult to understand for people not involved in modelling":** 1KE (EADS)
- **"The purpose of modelling was not clear to people not involved in APOSDLE":** 1 KE (CCI)
- **"The preparation of knowledge elicitation requires efforts and time"** 1 KE (EADS)
- **"Knowledge elicitation from experts did not lead to a lot of useful results":** 1 KE (CCI)
- **"Identification of task and concepts was easy for the expert":** 1 KE (CNM)

Objectives and explanations

- **"The objectives of the phase were clear":** 2 KE (CCI, ISN), 1 Coach (SAP)
- **"The explanations were clear"** 1 KE: ISN
- **"The explanations were clear for a person experienced in knowledge engineering but not for others":** 2 KE (CCI, CNM)
- **"Explanation of modelling processes and modelling methodology to non-KE was difficult"** 1 KE (CCI)

Experts

- **"Experts had difficulties to make implicit knowledge explicit":** 2 KE (ISN, CCI)
- **"Experts had problems to think in processes":** 1 KE (CCI)

Knowledge elicitation techniques

- **"Knowledge elicitation techniques were adequate":** 1 KE (EADS), 1 Coach (KC)
- **"Laddering was useful for the task model":** 2 Coaches (SAP, KC)
- **"Card sorting in a group was useful":** 1 KE (ISN), 1 Coach (SAP)
- **"Card sorting is fun":** 1 KE (CCI)
- **"Card sorting did not lead to useful results":** 1 Coach (KC)
- **"Classic structured interviews might have been useful":** 1 KE (ISN)
- **"Classic structured interviews might bring better results than card sorting":** 1 KE (CCI)

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8.2.2.2 Feedback both for the IMM of P2 and P3

Experts

- **"Experts had very little time"**

  P2: 3 KE (ISN, EADS, CCI), 2 Coaches (SAP, KC)

  P3: 1 KE (CCI)

8.2.2.3 Feedback on the IMM for P3

Modelling effort

- **"Modelling in this step took a lot of time":** 1 KE (CCI)
- **"It is challenging to reduce data from domain experts to tasks and topics":** 1 KE (ISN)
- **We had no coaching effort, everything was done by the KE":** 1 Coach (SAP)

Experts

- **"Experts were interested because they had a better understanding of the APOSDLE system and the modelling process":** 1 KE (CCI)
- **"Interviews with domain experts were useful":** 1 KE (CCI)
- **"Different experts have different perspectives on the domain, it is difficult to find overlaps":** 1 KE (ISN)

Knowledge elicitation techniques

- **"Knowledge elicitation workshops were useful":** 1 KE (ISN)
- **"A modified version of card sorting was applied":** 2 KE (ISN, EADS), 1 Coach (SAP)

8.3 Phase 2. Modelling of domain and tasks

8.3.1.1 Feedback on the IMM for P2

General

- **"Informal modelling is not necessary, we should have directly started with formal modelling":** 1 KE (CCI)
- **"It is essential to start from informal modelling before creating formal models":** 1 KE (EADS), 1 Coach (SAP)
- **"The intended granularity of the models was unclear":** 2 KE (ISN, CCI)
- **"There was a lack of understanding how the models would be used in APOSDLE":** 1 KE (EADS)
- **"The translation into different languages was time-consuming":** 1 KE (CCI)

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Objectives and explanations

- **"Modelling rules for the Wiki were not clear":** 1 KE (EADS)
- **"A manual for the Wiki was missing":** 1 KE (CNM)
- **"It was not clear how to handle the Wiki":** 1 KE (CCI)
- **"Explanations seemed clear, but results were partly wrong":** 1 Coach (SAP)
- **"The explanations were clear for a person experienced in knowledge engineering but not for others":** 1 KE (CCI)

Wiki

- **"The change of the semantic Wiki caused additional effort":** 3 KE (CCI, CNM, ISN), 1 Coach (SAP)
- **"AP models should be separated":** 1 KE (EADS)
- **"The semantic Wiki was inexpedient for modelling concepts and tasks":** 2 KE (CCI, CNM), 1 Coach (SAP)
- **"The semantic Wiki was useful":** 2 KE (ISN, EADS), 1 Coach (KC)
- **"It was unclear how to model relationships between concepts":** 2 KE (CCI, ISN)
- **"It was difficult to find the functionality for renaming tasks and concepts":** 1 KE (KC)
- **"The Wiki does not support the iterative modelling process": 1 KE (EADS)**
- **"Wiki functionality needs to be improved":** 1 KE (EADS)

Transferring the models to YAWL and Protegé

- **"Automatic translation from the Wiki to YAWL would have been helpful":** 1 Coach (SAP)
- **"There were minor technical problems with Protegé":** 1 KE (CCI)
- **"Protegé and YAWL were adequate tools":** 1 Coach (KC)
- **"Some relations got lost during the transformation from WiKi to Protegé":** 1 KE (ISN)
- **"YAWL is a useful tool":** 1 KE (CNM)
- **"Formal models were well-prepared by the technical partners (FBK, SAP)":** 1 Coach (KC)

8.3.1.2 Feedback both for the IMM of P2 and P3

Objectives and explanations

- **"The objectives of the phase were clear":**

  P2: 3 KE (ISN, EADS, CCI), 1 Coach (KC)

  P3: 1 KE (EADS), 1 Coach (FBK)

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- **Explanations were clear**

  P2: 1 KE (ISN)

  P3: 1 KE (EADS)

Wiki

- **"The Wiki was used in a collaborative manner by the knowledge engineers and their coaches"**

  P2: 1 Coach (SAP)

  P3: 1 Coach (FBK)

- **"The Wiki was not used in a collaborative manner among the KEs of different domains":**

  P2: 2 KE (CCI, ISN), 1 Coach (KC)

  P3: 1 KE (EADS)

8.3.1.3 Feedback on the IMM for P3

General

- **"Having less tools saved a lot of time":** 1 Coach (SAP)

Adaptation of methods

- **"MS Visio was used to build graphical domain and task models":** 2 KE (CCI, ISN)

Conceptual issues

- **"It was difficult to find labels for domain concepts":** 2 KE (EADS, CCI)

MoKi

- **"The MoKi was useful":** 3 KE (CCI, ISN, EADS), 2 Coaches (FBK, SAP)
- **"Description of how to use the "is part of" relation in the MoKi was missing":** 1 KE (CCI), 1 Coach (SAP)
- **"The user manual for the MoKi was good":** 1 KE (EADS)
- **"The Import functionality was useful":** 1 KE (EADS)
- **"It was better to have a separate MoKi for each partner":** 1 KE (EADS)
- **"The different visualisations of the domain concepts and tasks were useful":** 2 KE (CCI, EADS)
- **"MoKi supports the involvement of domain experts":** 1 Coach (FBK)
- **"Deleted concepts were still visible in the MoKi":** 1 KE (EADS)

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Transferring the models to Protegé

- **"Formal models were generated automatically (no effort)":** 2 KE (ISN, EADS), 2 Coaches (FBK, SAP)
- **"Moki to owl export tool is not available for KE":** 1 KE (EADS)

8.4 Phase 2a. Validation and Revision I

8.4.1.1 Feedback on the IMM for P2

General

- **"The evaluation of this phase was unclear":** 1 Coach (KC)
- **"It is hard to say when an informal model is finished":** 1 Coach (SAP)
- **"The KE cannot assess the quality of the model without the help of a coach or someone else":** 1 KE (ISN)

Objectives and explanations

- **"The explanations were clear for a person experienced in knowledge engineering but not for others":** 1 KE (CCI)

Experts

- **"Experts had very little time":** 1 KE (CCI)
- **"Experts were not available for model validation":** 1 KE (EADS)
- **"Experts were not interested in model revision"**: 1 KE (CCI)
- **"Experts were reluctant":** 1 Coach (KC)

Conceptual

- **"It was difficult to rate the relevance of single concepts":** 2 KE (CCI, EADS)
- **"Feedback about the quality of the model was missing or not critical enough":** 1 KE (CNM)

Wiki

- **"Getting an overview of the model was difficult in the Wiki":** 2 Coaches (SAP, KC)
- **"With the semantic Wiki it was possible to extract the relations so that a revision by domain experts could easily be done":** 1 KE (ISN)
- **"It was difficult to extract relation pages":** 1 KE (ISN)

Graphical visualisation of the models

- **"A graphical visuailsation of models was missing":** 1 KE (EADS), 1 Coach (SAP)

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Model revision

- **"Revision was done rather on a formal level than on a content-wise level":** 1 Coach (KC)

8.4.1.2 Feedback both for the IMM of P2 and P3

Objectives and explanations

- **"The explanations were clear"**

  P2: 1 KE (ISN)

  P3: 1 KE (EADS), 1 Coach (FBK)

- **"The objectives of the phase were clear"**

  P2: 3 KE (ISN, CCI, EADS)

  P3: 1 KE (EADS), 1 Coach (FBK)

8.4.1.3 Feedback on the IMM for P3

General

- **"Hints from the coaches were useful":** 1 KE (ISN)
- **"There were just minor changes in this step":** 1 Coach (SAP)

MoKi

- **"The MoKi was useful for model revision":** 1 KE (CCI)
- **"The "is a" and "part of" browsers in the MoKi were helped in validation and revision":** 1 KE (EADS), 1 Coach (FBK)

Check report

- **"The check report was useful and gave a nice overview":** 2 KE (ISN, EADS), 1 Coach (FBK)
- **"Somme errors were detected through the formal checks":** 1 KE (ISN)
- **"The formal check report was very long":** 1 KE (ISN)

Ontology questionnaire

- **"The ontology questionnaire was not used":** 1 KE (EADS)

8.5 Phase 3. Modelling of learning goals

8.5.1.1 Feedback on the IMM for P2

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General

- **"Modelling learning goals was difficult because of a lack of understanding of the role of models in APOSDLE":** 1 KE

Objectives and explanations

- **"Competency Types were sometimes unclear":** 1 KE (CCI)

TACT

- **"There were minor technical problems with TACT":** 1 KE (CCI)

8.5.1.2 Feedback both for the IMM of P2 and P3

Objectives and explanations

- **"The explanations were clear"**

  P2: 1 KE (ISN)

  P3: 1 KE (EADS)

- **"The objectives of this phase were clear"**

  P2: 1 KE (ISN)

  P3: 1 KE (EADS)

TACT

- **"The TACT tool was easy to implement and use"**

  P2: 4 KE (ISN, CCI, CNM, EADS)

  P3: 3 KE (EADS, ISN, CCI), 1 Coach (SAP)

- **"The TACT manual was very useful"**

  P2: 2 KE (CCI, EADS)

  P3: 2 KE (EADS, CCI), 1 Coach (SAP)

- **"There were minor usability issues in TACT"**

  P2: 1 KE (ISN)

  P3: 1 KE (ISN)

"TACT can be improved"

P2: 1 KE (EADS)

P3: 1 KE (EADS)

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8.5.1.3 Feedback on the IMM for P3

Modelling effort

- **"The learning goal model from P2 had to be transferred to P3. This step took a lot of time":** 1 Coach (SAP)

Objectives and explanations

- **"Description of the inheritance in the TACT was missing":** 1 KE (CCI)

TACT

- **"Inheritance of learning goals for sub-concepts was missing":** 1 KE (CCI)
- **"Multihierarchies were not visible in the TACT although they were in the MoKi":** 1 KE (CCI)

Variables

- **"Variables were useful to reduce the modelling effort":** 1 KE (ISN), 1 Coach (KC)
- **"Variables were not used to keep the model simple":** 1 KE (CCI), 1 Coach (SAP)
- **"It was difficult to understand how variables would be used in APOSDLE":** 1 KE (EADS)
- **"It was not difficult to understand how to use variables":** 1 KE (ISN)
- **"It was not difficult to insert variables in the MoKi":** 2 KE (ISN, EADS), 1 Coach (FBK)
- **"Variables were inserted in the MoKi":** 2 KE (ISN, EADS)
- **"Using variables can drastically increase the number of tasks":** 1 Coach (KC)
- **"Inserting variables in the TACT is easy":** 1 KE (ISN)
- **"It is useful that you insert variables in the MoKi and get hints in the TACT":** 1 KE (ISN)

8.6 Phase 3a. Validation and Revision II

8.6.1.1 Feedback on the IMM for P2

[This step was performed after the evaluation of IMM for P2]

- **"It is hard to say when a formal model is finished":** 1 Coach (KC)

8.6.1.2 Feedback both for the IMM of P2 and P3

[This step was performed after the evaluation of IMM for P2]

8.6.1.3 Feedback on the IMM for P3

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Objectives and explanations

- **"The explanations were clear":** 1 KE (EADS)
- **"The objectives of the phase were clear":** 1 KE (EADS)

Check report

- **"The check report was useful and gave a nice overview":** 2 KE (ISN, EADS), 1 Coach (FBK)
- **"The result of the check report rather concerns the technology partners":** 1 KE (EADS)

TACT

- **"The Excel sheet produced by the TACT was very useful for checking the learning goal model":** 1 KE (ISN)

8.7 General remarks

8.7.1.1 Feedback on the IMM for P2

- **"It was difficult to estimate the modelling efforts":** 2 KE (CCI, ISN)
- **"The organization of the modelling process was not clear":** 1 KE (CNM)
- **"We had difficulties with knowledge engineering because we had no experience with it":** 1 KE (CCI)
- **"There was a lack of understanding of the role of models in APOSDLE":** 1 Coach (SAP)
- **"The model was kept simple and was therefore easily manageable":** 1 KE (CCI), 1 Coach (SAP)

8.7.1.2 Feedback both for the IMM of P2 and P3

Complexity of the model

- **"The model does not allow to depict all necessary complexity of the domain"**

  P2: 1 KE (EADS)

  P3: 1 KE (EADS)

8.7.1.3 Feedback on the IMM for P3

Modelling efforts

- **"The modelling process is still time consuming":** 1 KE (CCI), 1 Coach (SAP)
- **"Speed up modelling is crucial for a real-world application":** 1 KE (CCI)
- **"Time to be invested in modelling is acceptable":** 1 Coach (SAP)

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Role of the modeller

- **"Modelling cannot be done by people who have no experience in knowledge engineering":** 2 KE (CCI, ISN), 1 Coach (SAP)
- **"The knowledge engineers were domain experts at the same time":** 1 KE (CNM)
- **"Modelling was done by a KE and not by a DE in every stage":** 3 KE (ISN, CCI, EADS), 2 Coaches (KC, FBK)

Modelling tools

- **"It would be nice to have everything integrated in one tool":** 1 KE (ISN)

Model revision

- **"Changing the model once it is finished is still difficult":** 1 KE (ISN)

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9 Annex

Content:

- Part 1: Initial questionnaire (Scope & Boundaries)
- Part 2: MoKi User Manual
- Part 3: Validation & Revision of Domain + Tasks
- Part 4: TACT User Manual
- Part 5: Validation & Revision of Learning Goals
- Part 6: Filled Feedback Questionnaires on the Integrated Modelling Methodology
    - CCI
    - EADS
    - ISN
    - KC
    - SAP
    - FBK

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Initial questionnaire
(Scope & Boundaries)

General Questions			Implications
In which branche is your company?	closed	research, consulting…	
How is your company organised? (centrally organised, family enterprise, very distributed etc.)	closed	network of smaller companies small company etc.	
How many employees does your company have?	open		If it is small, has the same employees since many years, and is at one location, these are strong indications against APOSDLE.
What is the learning domain that you want to support with a learning system?	open		
Who is the target group that you want to support with a learning system?	open		
In your company, how many employees are working in the field which you want to support with the learning system?	open		
In your company, how many employees should be supported with the learning system?	open		

Please answer the following questions with the target group of the learning system in mind.

For the target group of your learning system, how long would you say that job incumbants are typically holding their jobs, i.e. to what extent, positions and tasks for one employee are fluctuating over time?	closed	<2 years, between 2 and 5 years, between 5 and 10 years, > 10 years	If fluctation is high, APOSDLE can help the company "keep" the knowledge of leaving employees and transmitting it to newly hired employees
What do you think, which amount of their work do employees of the target group perform on their computers?	closed	0-25% 26-50% 51-75% 76-100%	APOSDLE is inherently computer-based. For instance, tasks that are not done on a computer can not be detected. But APOSDLE also offers a lot of functionality without task detection (learning by browsing or planning, search, browsing)

What do you think, how typical is it for the target group of the learning system, that for perfoming their tasks they have to…

...search for and find existing knowledge from various sources (e.g., internet, databases, archives, libraries)?	closed	very typical somewhat typical not very typical not typical at all	APOSDLE strongly supports finding knowledge.
...apply knowledge and skills that they have acquired in the past for perfoming tasks, or solving problems (e.g. repairing a machine, or program, diagnosing errors)?	closed	very typical somewhat typical not very typical not typical at all	APOSDLE strongly supports applying knowledge (task-based learning)
...package knowledge, in order to make information available to others (e.g. writing information materials, consulting customers)?	closed	very typical somewhat typical not very typical not typical at all	APOSDLE only partly supports packaging knowledge (by creating collections of existing learning material that can then be shared with other APOSDLE users)
...create new knowledge, e.g. they invent new things, or they research on a specific topic?	closed	very typical somewhat typical not very typical not typical at all	APOSDLE does not support creating new knowledge, although it can offer the opportunity to do so, for example by supporting collaboration.

Questions about the role of "learning" in your organisation

How important are knowledge workers, i.e. people who apply, package, create, or find new knowledge in your company?	closed	not important at all not very important somewhat important very important	If knowledge workers are not (felt to be) central, configuring APOSDLE may be too time-intensive
How is knowledge work, i.e. finding, applying, packaging, or creating new knowledge rewarded in your company?	open		
Are employees in the target group expected to continuously learn / keep up to date with new developments?			If this is not important, then an existing LMS with ready-made learning material might be a better option.
By now, are learning systems or learning management systems used in your company?	closed	yes, no	
if yes…			
Which learning systems or learning management systems do you use in your company?	open		
Why do you want to have a learning system for your target learning domain?	?	strategic decision to build expertise in the topic; collect expert knowledge	If there is a strategic reason, this is a good indication for APOSDLE, as employees / management will probably be prepared to invest some resources into APOSDLE

What do you expect of a learning system for your target learning domain?	open		If there are not very clear expectations, these should be worked out. If the expectations are clear, but do not correspond to what APOSDLE does, this should be discussed
What do you expect of APOSDLE for your target learning domain? Which functionalities do you expect?	open		

Questions about the work that is performed in the target group

For the following statements please indicate how much you agree or disagre with respect to the target group of you learning system…

Workers in the target domain are frequently facing tasks where they do not exactly know what they should look for.	closed	yes rather yes rather no no	If someone knows what she is looking for, a keyword-search is usually faster/more convenient; If not, “APOSDLE helps where other, traditional search-engines cannot help” Having a task and not knowing "how to start" looking for a solution is a challenge. If this challenge is at the "right" level of difficulty, this increases motivation/self-efficacy. This again increases ability. The execution of such tasks are a primary indicator for Knowledge Work. APOSDLE can help with getting such tasks to the right level of difficulty by providing learning support in accordance with personal skills/competencies.
Many of the tasks in the target group are routine jobs with exact process definitions.	closed	yes rather yes rather no no	This indicates routine jobs, that could probably better supported by workflow management systems. APOSDLE can not enforce a workflow.
In the target group, each employee should be able to do every task.	closed	yes rather yes rather no no	If specialisation is high, a learning system for a shared domain might not be helpful. APOSDLE however profits from a learning domain in which for every task there are multiple people participating that can also support someone just learning a task.
In the target group, the tasks of one employee my vary significantly with respect to the knowledge and skills that are required for performing the task.	closed	yes rather yes rather no no	If not, this may indicate that an employee only needs to learn once what is required for her tasks. APOSDLE pays off best, when continuous learning is necessary. On the other hand, this may indicate that there is no fixed learning domain. This is a counterindicator for APOSDLE as the learning domain needs to be modelled.
Usually, employees in the target group perform tasks "from the beginning to the end".	closed	yes rather yes rather no no	This is an indicator for knowledge work. If there are a lot of counter-indications for knowledge work this probably speak against using APOSDLE in this context.
Usually, employees in the target group perform tasks with a meaningful outcome, e.g. a report, or a product, where the outcome can be attributed to the employee.	closed	yes rather yes rather no no	This is an indicator for knowledge work. If there are a lot of counter-indications for knowledge work this probably speak against using APOSDLE in this context.
In the target group, for a task it can usually be said easily whether the outcome was good or bad.	closed	yes rather yes rather no no	This is a sign for complex tasks, which require a complex kind of feedback and competency assessment. APOSDLE supports this by making use of a variety of knowledge indicators.
For many of the tasks in the target group, the process definition is fuzzy.			This indicates that tasks can be done in different ways. Workflow support systems fail in such situations. Learning from the experience of colleagues becomes more import. This points towards using APOSDLE.
Tasks that employees in the target group are performing are crucial to the success of the company.	closed	yes rather yes rather no no	This asks for the inherent commitment of the company to APOSDLE. If the process is central, then people will be more willing to invest in modelling and annotating and hopefully more motivated to "give APOSDLE a chance". Basically it asks for the desire to have a complex learning system.

Questions about the learning domain

With a learning system, do you want to support employees who want to learn how to perform steps of a process?	closed		If there is no underlying process (for instance people are interested in factual knowledge only), APOSDLE is maybe not the first choice, as it is inherently task-based. However, also without tasks, APOSDLE has the potential to provide many benefits (learning support integrated with annotated material, browsing by topics, contacting users with similar topics etc.)
Does the knowledge that is required for performing one and the same task possibly differ in different situations?			If it does, this indicates that there is no strong link between the executed task and the knowledge that people should learn, i.e. people do not want to learn about the task, but about something else. We call this "orthogonality between task and learning domain". If this is the case, this must be taken into account when modelling.
Do the topics in your target learning domain remain rather stable over time, or do they change frequently?	closed	stable/change frequently	If they change frequently, this is a counter-indication for APOSDLE, since all knowledge needs to be modelled, and evolution of modelled knowledge is not one of the focal points of APOSDLE.
Do employees in the target group usually produce electronic documents during their daily work?	closed	yes rather yes rather no no	There is an evolving pool of learning materials => “feedback-loops”. Task results (documents) come back into the system and serve as learning content Up-to-date documents are available to be fed into the system.
Is there a sufficient amount of documents available, which can serve employees as learning content?	closed	yes rather yes rather no no	If not, it must be discussed where the expertise for modelling the domain can be acquired (bought/hired). If there are no resources, this is a strong counter-indicator for APOSDLE however, since APOSDLE can only facilitate access to existing digital and also human resources.
Do you have people in your target group who know the learning domain very well?			
Is it necessary to invest a signific amount of time in learning, in order to become an expert in the learning domain?			

Questions about employees in the learning domain

Do employees in the target group usually really "want to learn" and to improve their knowledge and skills?	closed	yes rather yes rather no no	If users are not motivated, a learning support system is probably not useful.
Would employees in the target group like to benefit and learn from the documented experience of colleagues?	closed	yes rather yes rather no no	If employees are not interestred in their colleagues' experience (written, direct advice), this is a counterindication of APOSDLE. In this case maybe a traditional LMS could be tried.
Do employees in the target group usually have time to learn new things, if necessary?	closed	yes rather yes rather no no	Checks organisational commitment to learning. If employees do not have time to learn, this must be discussed - learning also takes time when using APOSDLE.
Do employees in the target group, at their workplaces usually have the possibility to exchange their knowledge and experience with colleagues from different fields?	closed	yes rather yes rather no no	This is a possible indicator for APOSDLE, as it potentially creates opportunities of contacting other employees.
Do employees in the target group work together in one open office, or do they work spatially separated?	closed	together, separated	This is an indicator for APOSDLE as it creates opportunities of contacting other employees via computer. If all persons in the target group work together in one room, the benefits of APOSDLE may not be that large.
Are employees in the target group of the learning system used to self-directed learning, i.e. are they capable of self-reflection about their learning needs and learning progress?	closed	yes rather yes rather no no	

Quesions about current practices

Does a learning system or learning management system currently exist for the target learning domain in your company?	closed	yes, no	If yes, then why APOSDLE? There must be a good reason for that. For instance: current documents shall be included, there are multiple LMS from which APOSDLE should collect material etc.

if yes..			
Which learning system or learning management system exists for the target learning domain in your company?	open		
How do experts in the target learning domain usually support colleagues who need help?	open		If experts have little time to support colleagues, or often point them towards somewhere in the shared document repositories, this is an indication for APOSDLE. That's just what APOSDLE should also do. Although it cannot replace experts, it can take some load off them.
What are the tools and strategies that employees in the target domain currently apply in order to find what they need to know?	open		If employees in the target group are very comfortable with the search possibilities they have, and usually find what they are looking for, APOSDLE may not add a significant improvement.
How do employees in the target learning domain usually communicate with each other?	open		If employees have good strong personal communcation with each other, this is a counter-indicator for APOSDLE as it may not add significant improvement.

Many thanks for your help!

How to use the MoKi[1]

Chiara Ghidini

Draft of November 20, 2008

[1]Thanks to Viktoria Pammer, Marco Rospocher, and Andreas Zinnen for their valuable feedback.

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1 Introduction

The modelling wiki (MoKi) is a collaborative tool that provides support for enabling domain experts, who do not necessarily have knowledge engineering skills, to model business domains and simple processes directly.

Wiki templates and functionalities guide the domain experts through the necessary steps. Some knowledge of basic modelling steps, as described in [1] are required. Users unfamilar with the steps of the Integrated Modelling Methodology for APOSDLE should refer to the description in [1] or ask their coach for a summary of the basic modelling process.

2 Wiki main functionalities

The functionalities of the wiki can be classified in 4 groups, which can be found in the left hand side bar of Figure 1:

1. **Wiki Import Functionalities**. These functionalities support a compact import of groups of concepts and tasks to facilitate the early phases of modelling.
2. **Domain Model Management**. These functionalities support the management of domain model elements.
3. **Task Model Management**. These functionalities support the management of task model elements.
4. **Wiki Owl Export functionalities**. These functionalities support the automatic export of knowledge about the domain model (task model resp.) in OWL.

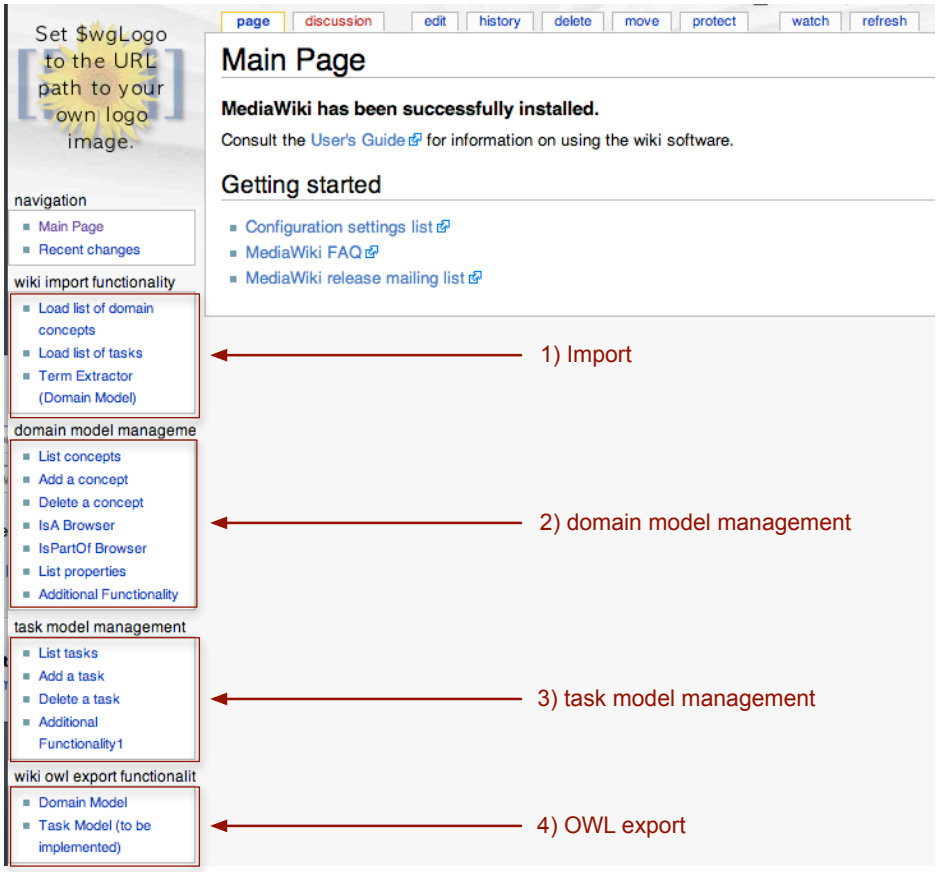


Figure 1: The wiki main page.

3 Wiki Import Functionalities

The support a compact import of groups of concepts and tasks to facilitate the early phases of modelling. Here we illustrate the behaviour of all of them.

3.1 Load List of Concepts

Load List of Concepts allows to enter a textual list of concepts and to import all of them in the wiki. To import the list of concepts you can type them (or paste them) in the textual form in a dedicated form, **one for each row** (see Figure 2).

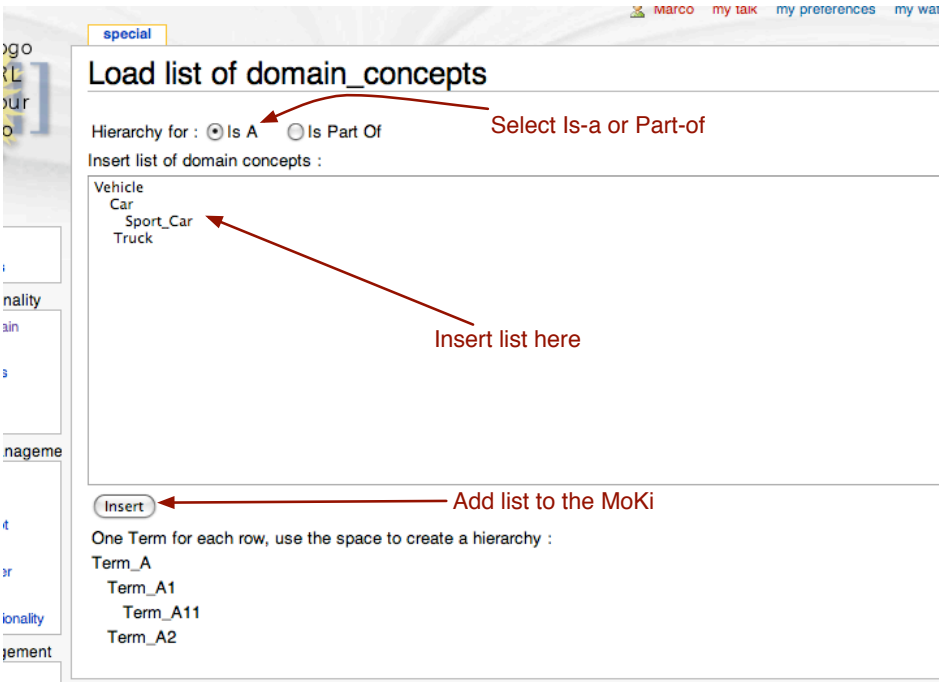


Figure 2: Load List of Concepts

After clicking on the "Import" button all the terms will be added as concepts to the wiki, and templates for these concepts are automatically created. The list of all concepts present in the wiki can be accessed via the **List Concepts** functionality (see Section 4.2 at page 7).

Indentation can be used to organise the concepts in an *is-a* hierarchy or in a *part-of* hierarchy. To select the appropriate hierarchy you can use the selector on the top of the page.[1]

Note: With the current version of the MoKi the usage of the import functionality more than once could result in a loss of data stored in already created pages. Therefore we suggest to use the import functionality only once at the start of the modelling activity and to choose whether to import an is-a or a part-of hierarchy. Extensions of the wiki which overcome this problem and allow to use the import several time maintaining he consistency of data are planned and will be announced in due course.

[1]For more information about Is-a and part-of hierarchies see Section.

Note: The insertion of a flat (that is not indented) list of terms will result in the insertion of a flat list of concepts in the MoKi.

The information about the is-a and part-of hierarchy is automatically saved in the templates of the relevant concepts (see section 4.1).

3.2 Load List of Tasks

The behaviour of **Load List of Tasks** is analogous to the one of **Load List of Concepts** illustrated in Section 3.1. The main difference is that indentation is used here to store information about the sub-task hierarchy (see Figure 3).[2]

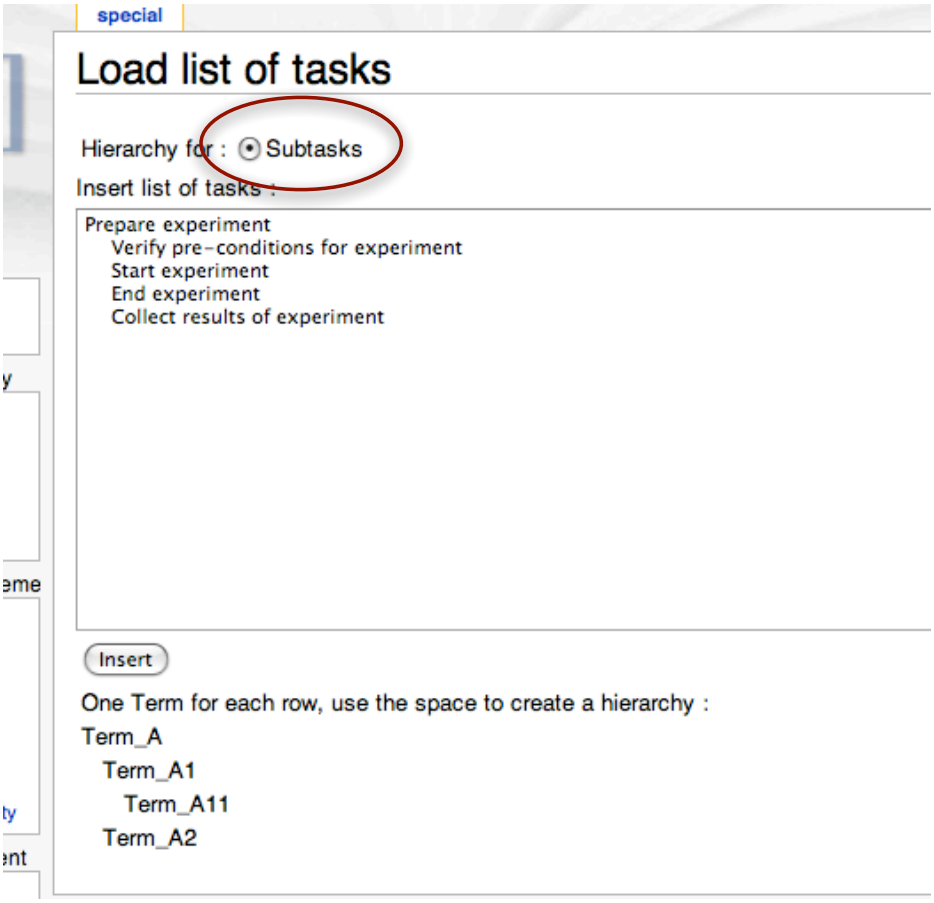


Figure 3: Load List of Tasks

3.3 Term Extractor

The **Term Extractor** allows to extract terms from documents and to add them to the concept list of the MoKi. Supported formats of files are ascii and pdf.

[2]For more information about the sub-task hierarchy please contact your coaches.

First, the user has to upload the files from which the terms have to be extracted. To do that a button "Choose files" allows to browse the local file system and select files. Once a file has ben selected it can be added to the list of current files by clicking on the "Upload File" link. The uploaded files are displayed in the section "Files". In the example in Figure 4 two files "Modelling_ExampleEADS.pdf" and "collaborative1.pdf" have been selected so far for term extraction. These files are also available for downloading.

Once the files have been uploaded then the user can (should) select the language in which the documents are written.

After that terms can be extracted by clicking on "Extract relevant terms" or "Cluster Relevant Terms and get relevant terms for cluster"[3]

The terms extracted can be viewed by clicking on the "+" symbol next to **Terms**. By clicking on a concept this is added to the MoKi and a template is shown where to enter all the information about that concept (see Section 4.1)

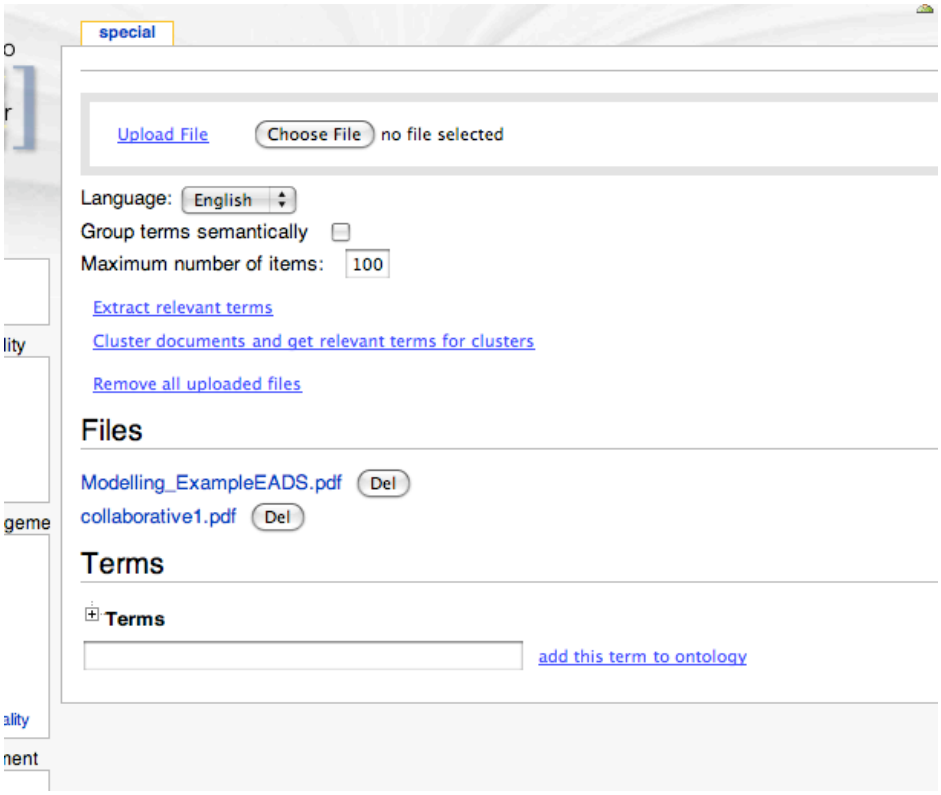


Figure 4: The Term Extractor

The additional functionality "Remove all uploaded files" can be used to remove all the uploaded files at once.

For further details on the Term Extractor please contact Viktoria Pammer.

[3]For further details on the Term Extractor please contact Viktoria Pammer.

4 Domain Model Management

These functionalities support the management of domain model elements. Each element is stored as a wiki page, and the information is structured according to pre-defined templates.

4.1 Templates for Concepts

A typical template for a concept is shown in Figure 5. Is shows the information stored in the wiki for the specific concept. The tabs listed in the upper part of the template provide basic functionalities to manage the template:

- **edit with form**. This tab enables to edit the information contained in the template with a form-based interface. Note: auto-completion is used to suggest how to fil the forms with already existing elements of the wiki.
- **edit**. This tab enables to edit the information contained in the template directly with the semantic media wiki syntax.
- **history**. This tab enables to see the history of changes of the current page.
- **delete**. This tab enables to delete the current concept.
- **move**. This tab allows to rename the current concept.

Please refer to your coaches for a description of the information that must be added in the fields of the different templates.

4.2 List concepts

The **List concepts** functionality creates a table which lists all the concepts contained in the wiki and their main properties. By clicking on a concept, the template of that concept is shown.

4.3 Add a concept

The **Add a concept** functionality allows to add or edit a concept in the wiki. If the concept is new, then it is added to the wiki. The user is automatically shown the empty template (with form) for the new concept so that the relevant information can be entered. If the concept already exists then its form is retrieved and the user can update it.

4.4 Delete a concept

The **Delete a concept** functionality allows to delete a concept from the wiki. In the current version the list of concepts is shown. The user can select the one to delete and then delete it from its template as explained in Section 4.1.

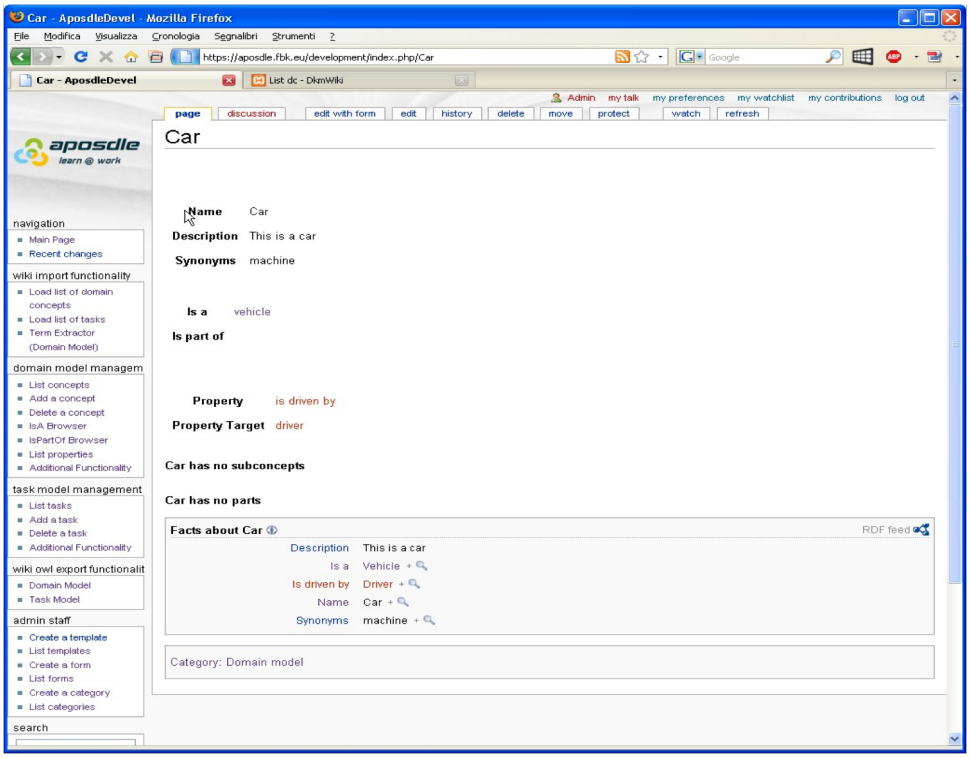


Figure 5: A template for a concept.

When deleting a concept, the references to that concept will remain "pending" and have to be fixed by hand. To overcome this problem we suggest to delete only concept which have no sub-classes or sub-parts. Also it is better to ensure that the concept to be deleted do not provide domain and range information for properties. If a concept to be deleted has sub-class and/or sub-part concepts, the is-a and part-of browsers can be used to move the children concepts to their new "location" in the hierarchy (or this can be done by editing the same information in the templates).

4.5 IsA Browser / IsPartOf Browser

The **IsA Browser** functionality allows to visualise and update the is-a hierarchy of concepts using a graphical interface and drag and drop functionalities. Once the hierarchy has been reorganised the user has to click on the "save Tree" button to save the changes in the MoKi. The information on the Is-a hierarchy in the templates is automatically updated.

The behaviour of the **IsPartOf Browser** functionality is analogous. This functionality allows to manage the is-part-of hierarchy instead of the is-a hierarchy.

4.6 List properties

The **List properties** functionality creates a list of all the domain specific properties (relations) contained in the wiki.

Note: In the current version of the MoKi also the following meta-properties used in the templates are displayed:

- Description
- Has default form
- Has subtasks
- Is a
- Is part of
- Synonyms

Please ignore them as they are **not** exported as domain specific relations in OWL (Protege).

4.7 Additional Functionaliies

This section is empty in the currect MoKi.

5 Task Model Management

The functionalities of the **Task Model Management** are a subset of the ones explained for the **Domain Model Management** in Section 4 and have a similar behaviour. The main difference here is the different template used or tasks (shown in Figure 6)

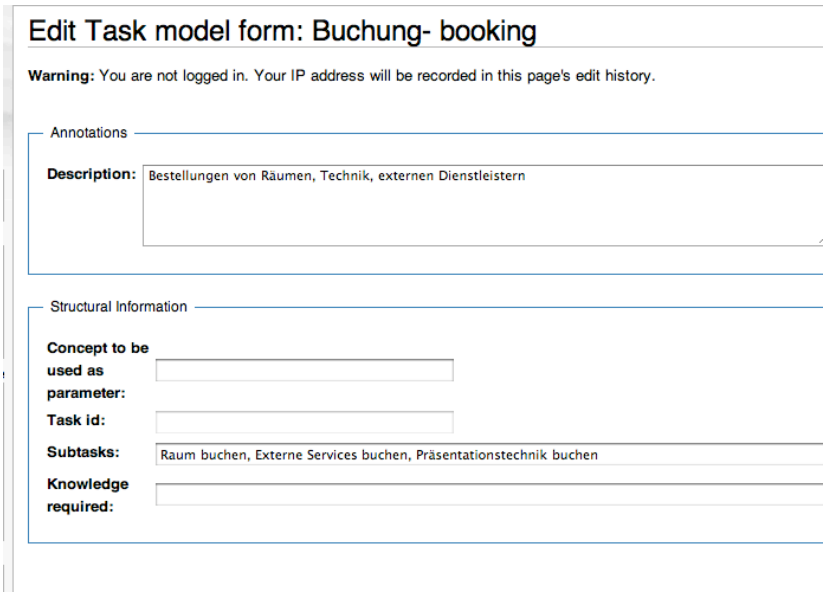

Edit Task model form: Buchung- booking
Warning: You are not logged in. Your IP address will be recorded in this page's edit history.
Annotations
Description:
Bestellungen von Räumen, Technik, externen Dienstleistern
Structural Information
Concept to be used as parameter:
Task id:
Subtasks:
Raum buchen, Externe Services buchen, Präsentationstechnik buchen
Knowledge required:

Figure 6: A Task Template

Please refer to your coaches for a description of the information that must be added in the fields of the different templates.

6 Owl Export Functionalities

These functionalities allow to automatically export the information contained in the wiki in OWL format. **Export Domain Model** allows to export the domain model, while **Export Task Model** exports the task model.

Note: Currently only the export of the domain model is implemented.

Note: the behaviour of the export differs from browser to browser. In some browsers the owl file is automatically downloaded, in others it is shown, in others a while page is shown and the command "show page source" has to be used to see the owl source.

7 Additional Concepts

7.1 Is-a and Part-of hierarchies

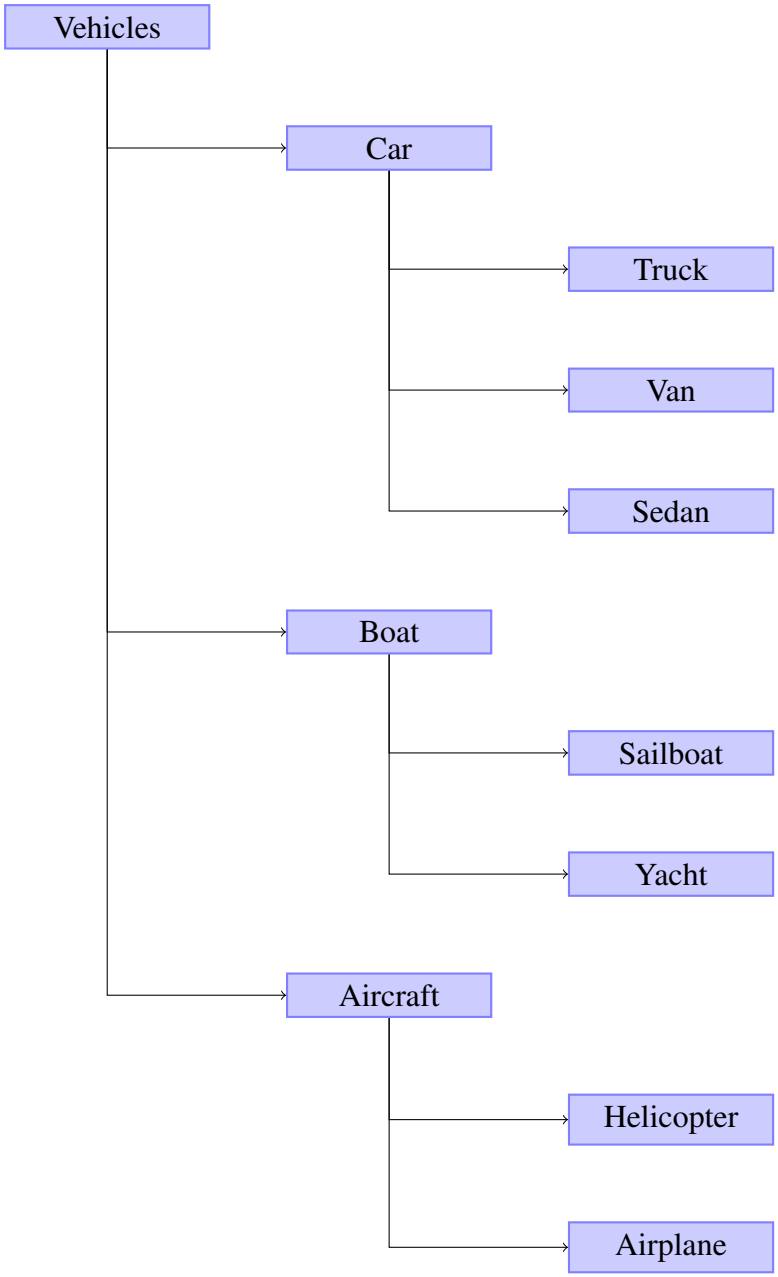
Is-a hierarchy The Is-a relationship (pronounced "is a") is a data relationship that indicates a type/subtype data relationship and should be already a familiar concept to persons with knowledge of Object Oriented Programming. The Is-a based approach to modelling recognizes that many types or classes of an individual entity can exist: for instance, in a "vehicle" domain an individual entity (that is a specific vehicle) can be a Car or a Boat or an Aircraft. In turn Boats can be Sailboats or Yachts, and so on. This note not intended to cover extensively this topic, but only to provide some basic examples of is-a relations which can be used as examples to build an is-a hierarchy. The Is a example below is based on an example described in [3].

Example 1. Consider a (over simplified) description of a vehicle dealership and its decomposition in sub-classes

- The top class of this domain is the class Vehicle;
- Vehicles can be partitioned into Car, Boat, and Aircraft;
- within the car class, the classes could be further partitioned into classes for Truck, Van, and Sedan;
- within the Boat class, the classes could be further partitioned into classes for Sailboats or Yachts;
- within the Aircraft class, the classes could be further partitioned into classes for Helicopter and Airplane.

The Car class, because it IS-A Vehicle, would inherit the properties of the Vehicle class. Analogously, the Van class IS-A Car, which in turn IS-A Vehicle, ad therefore objects of the Van class inherit all behaviors relating to the CAr and Vehicle classes.

These Is-a relations can be represented in a hierarchical structure as follows:



Further properties related to is-a hierarchies and sub-classes can be usually specified in Ontology building. Typical examples of these properties are:

- whether the subclasses provide a complete decomposition of the superclass. In our example we may want to specify if the subclasses Car, Boat, and Aircraft provide a complete decomposition of the class Vehicle or whether there can be Vehicles which do not belong to any of these classes.
- whether subclasses are disjoint. In our example we may want to specify that Boat and Aircraft are disjoint and there cannot be individuals which are both a Boat and an Aircraft, or we may want to allow the existence of individuals (e.g. a Seaplane) which can be considered both Boats and an Aircrafts.

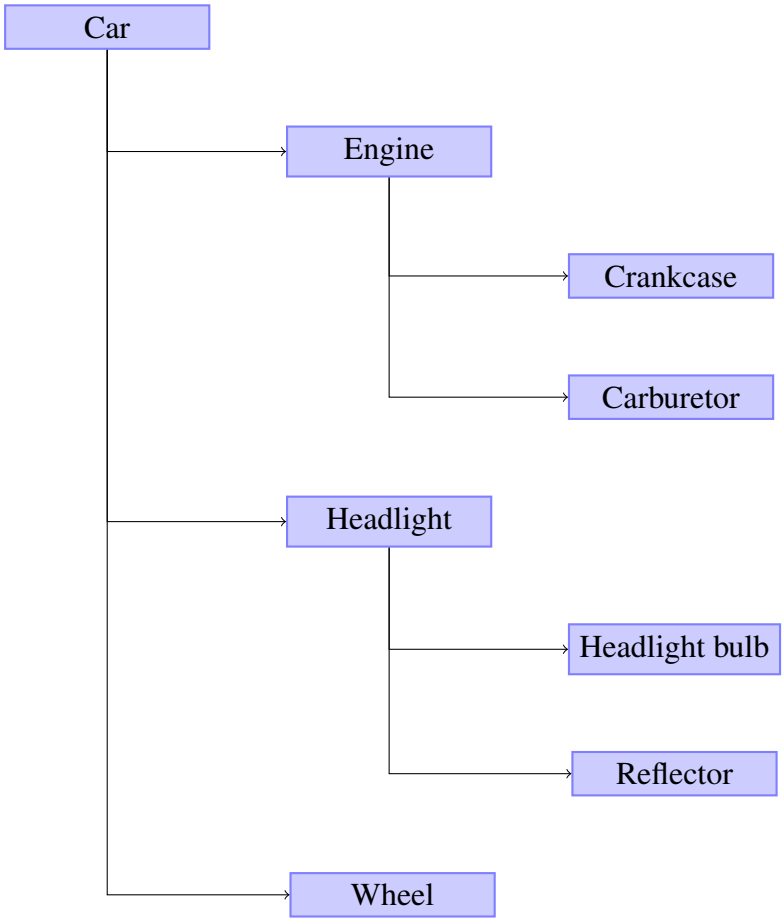
The current version of the MoKi does not allow you to specify these further properties of the is-a hierarchy, which will have to be added to the extracted OWL ontology using an ontology editor (eg. Protégé). For further instructions on how to model is-a hierarchies in Protégé please refer to [2].

Part-of hierarchy The Part-of hierarchy is meant to represent part-whole relations between the concepts stored in the MoKi. The study of part-whole relations is an entire field in itself, called "mereology". This note not intended to cover extensively this topic, but only to provide some basic examples of part-whole relations which can be used as examples to build a part-of hierarchy. The Part-of and example below is based on an example described in [3].

Example 2. Consider a (over simplified) description of a car and its decomposition into parts, subparts, etc.

- Cars have parts Engine, Headlight, Wheel;
- Engines have parts Crankcase, Carburetor;
- Headlights have parts Headlight bulb, Reflector;

These part-whole relations can be represented in a hierarchical structure as follows:



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[3] Natasha Noy and Evan Wallace. Simple part-whole relations in owl ontologies. http://www.w3.org/2001/sw/BestPractices/OEP/SimplePartWhole/simple-part-whole-relations-v1.5.html.

Project Number **027023**
APOSDLE: Advanced Process Oriented Self-Directed Learning Environment
Integrated Project
IST – Technology enhanced Learning

Validation & Revision of Domain + Tasks

Integrated Modelling Methodology

APOSDLE Identifier	APOSDLE-W10-JRS-Agenda-Plenary-and-GA-Trento
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4	2008-10-16	Document revised adding steps

1 Introduction

This document has the goal of guiding Application Partners and Coaches through a list of checks and suggestions to be used to refine and tune the models expressed in the **Mo**delling Wi**Ki** (MoKi).

All the checks should be performed between October 24 and November 7. The changes of the domain model and the task model triggered by the list of checks and suggestions described here should be made in the MoKi by the application partners supervised by their coaches.

In the following we provide an overall overview of the revision process and its main steps (Section 2 - Brief description of the overall process), then we illustrate the steps more in detail, both for the domain model and for the task model.

2 Brief description of the overall process

The revision process is divided in three main steps:

1. **Manual checks**. This part consists of a list of suggestions to manually check and validate the list of concepts contained in the domain model and the list of tasks contained in the task model of the MoKi. These suggestions and checks can trigger updates and modifications to improve the models directly in the MoKi.
2. **Automatic checks**. This part consists of a list of automatic check that will be performed to verify certain properties of the concepts and tasks described in the MoKi. The results of these checks will be sent to the Application Partners and coaches to help them revise the models contained in the MoKi.
3. **On-line questionnaires**. These questionnaires, accessible on-line to an address which will be communicated to each Application Partner in due course, propose to the Knowledge Experts statements and questions that are extracted from the models contained in the MoKi and aim to verify if the Knowledge Experts agree with those statements (if not, this obviously triggers a request for some manual verification and revision of parts of the models contained in the MoKi).

Steps 1 and 2 can be performed in parallel and concern both models (task and domain). Step 3 has to be executed after 1 and 2 and concerns only the domain model as Shown in Figure 1.

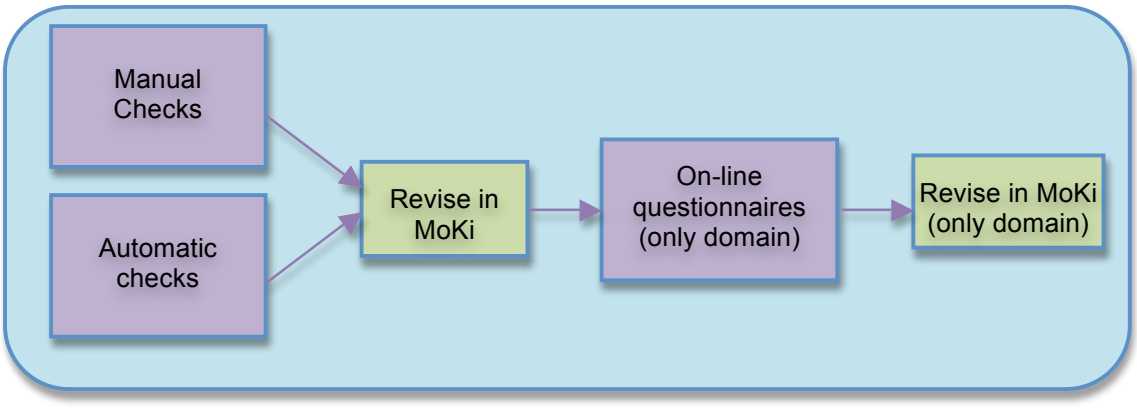

Figure 1 - The Revision Process

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3 Manual Checks

The two lists of checks described in this section are meant to guide Application Partners and Coaches to reflect upon the domain and task models created in the MoKi and evaluate whether some parts can be improved or need to be modified. Some of these suggestions require some understanding of knowledge engineering and therefore need an active involvement of the coaches (together with the APs).

3.1 Domain Model

- **Completeness of Concepts**: Are there relevant concepts missing from the MoKi?
- **Granularity**: are the concepts useful for supporting learning? Are they too broad, or too detailed?
- **Relations between concepts**: are the relations modelled in the MoKi correct? Are the different types of relations (is-a and part-of) used correctly? Would other, self-defined relations be more useful for expressing the relation between two concepts? [Coaches should provide support to this check]
- **Hierarchy**: Should some (very similar) concepts be grouped into a superordinate class? [Coaches should provide support to this check]
- **Concepts vs tasks**: Are all concepts "domain concepts", or should some of them be modeled as tasks?
- **Descriptions**:
    - Are the descriptions comprehensible? Do they make sense? (Suggestion: is possible ask an "external person" to read the descriptions and see if they make sense)
    - Are the descriptions correct for the given concept?
      As a fictitious example assume that the concept "Erfindungen von ArbeitnehmerInnen" (Inventions of employees) has the description "legal regulation for inventions of employees […]". This description does not exactly describe its concept and it seems that the Knowledge Expert "means something different" than what is indicated in the label. This may be a problem for APSODLE as this could lead to some ambiguity in the annotations and in the learning goals.

3.2 Task Model

- **Labels**:
    - Are the labels easy to understand for people who don't know APOSDLE?
    - Are the labels too short/long? Please remember that very short labels bear the risk of not meaning much to the user. Analogously unnecessary long or convolute Concerning long labels, again too complex names bear the risk of not meaning much to the user, and also could result in being too long for a nice user interface. As a guideline we will provide an automatic check which lists tasks with names longer that 30 characters This is not necessarily an error but a stimulus to think of the name can be shortened (see automatic checks below)
- **Relevance for learning**: Would people want to learn about the tasks in the task model?
- **Granularity** of the task model: is it too coarse or too fine grained?
  The decision whether the task list is fine-grained enough depends on the intended use of the learning environment, and on the intended target group, and is hence on the knowledge engineer. As a rough guideline, the task should allow for a manageable amount of learning goals that can be acquired in a reasonable time by the intended target group, to allow for work-integrated learning. [IMM P2]

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- **Descriptions**:
  - Are the task descriptions correct?
  - Are the descriptions easy to understand, i.e. helpful for a person who wants to learn about the task
- **Variables**:
  - Are there tasks that have variables but should **not** have variables?
  - Are there tasks currently without variables that should have variables? [Coaches should provide support to both checks]
- **Knowledge required**: Are the concepts in the "knowledge required" section correct – are they really required?

4 Automatic checks

These checks will be performed automatically (ie via appropriate scripts). The results will be provided by FBK at the beginning of the revision process to the coaches. The coaches will send them to the Application Partners, and they together will coordinate on how to revise the models in the MoKi accordingly.

4.1 Domain Model

- **Descriptions:** Do all concepts have descriptions? If there are missing descriptions, please add them in the MoKi.
- Are there top level concepts (that is very general concepts at the first level in the hierarchy) with no children? Note: This is not necessarily an error. Only a stimulus to consider if these concepts should have also more specific sub-concepts or if they should be discarded. [Coaches should provide support to this check]

4.2 Task Model

- **Descriptions**: Do all tasks have task descriptions? If If there are missing descriptions, please add them in the MoKi.
- **Variables**:
  - Do all concepts that are listed as variable also exist in the list of concepts
  - Is the variable of a subtask the same variable of the supertask?
  - Are the variables part of the task name? [Coaches should provide support to these three checks]
- **knowledge required**:
  - Do all concepts that are listed in the "knowledge required" section also exist in the list of concepts? Are there tasks without knowledge required? (This is not necessarily an error but a stimulus to check if some Knowledge required can be added) [Coaches should provide support to both checks]
- **Task identifier**: Do all tasks have a task identifier (number)? [Coaches should provide support to this check]
- **Long names**: Are there tasks with names longer that 30 characters (This is not necessarily an error but a stimulus to think of the name can be shortened to ease the display in the user interface and make the task more comprehensible to the end users of APOSDLE)

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1 Ontology Questionnaire

These questionnaires are meant to propose to the Knowledge Experts statements and questions that are extracted from the models contained in the MoKi and aim to verify if the Knowledge Experts (KE) agree with those statements. If not, this obviously triggers a request for some manual verification and revision of parts of the models contained in the MoKi. The questionnaire concerns only the domain model.
APs should use it on-line once the first revision (manual and automatic checks) is completed.

The ontology questionnaire is made for the purpose of letting a Knowledge Expert verify the "knowledge" that can be inferred from an ontology and remove it in case it was not intended. The rationale behind this is, that neither the knowledge expert nor the knowledge engineer explicitly state wrong things. Nevertheless, they might encode their knowledge in the ontology in such a way that they do not agree with everything that can be inferred from it. This can be due either to not well knowing the used formalism (OWL DL) or to having a large and complex domain ontology. After seeing the inferred statements, the KE or knowledge engineer might disagree with an inferred statement and wish to remove it. This is not directly possible because it is inferred and not stated. The ontology questionnaire finds the reason for an inferred statement, and lets the user remove the reason for the inference.

In the following I use the terms "axiom" and "statement" interchangeably.

1.1 Conceptual walk through the ontology questionnaire

The ontology questionnaire uses a reasoner on an (OWL DL) ontology to infer statements.

Example: "ANOVA subClassOf Test" is a statement. It states that the concept "ANOVA" is a subclass of the concept "Test". Other ways of expressing this could be: "Everything which is an ANOVA is also a Test" (in nearly natural language) or " $ANOVA \subseteq Test$ (in a formal language).

It then shows the list of inferences to the knowledge expert. The knowledge expert should read through these statements carefully. In case of disagreeal, the knowledge engineer can get the reason why this statement was inferred.

Example: "ANOVA subClassOf Test" was inferred because of the statements "ANOVA subClassOf Parametric_Test" and "Parametric_Test subClassOf Test". If the KE disagrees, either of the two statements must be removed. Then, the offending statement "ANOVA subClassOf Test" will not be inferred anymore from the ontology.

Aposdle - Specific

One important point for the usage of the Questionnaire in APOSDLE is, that although the changed ontology can in principle be saved directly, for APOSDLE you must note the axioms you deleted and delete them manually in the MoKi. How this can best be done is also described in detail below – we expect that to be quite fast and easy however.

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1.2 Step-by-Step through the Questionnaire

1.2.1 Start the questionnaire

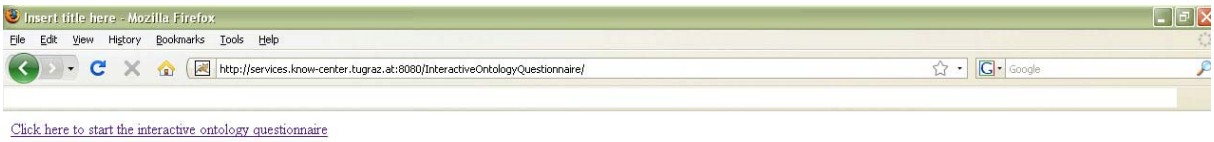
Insert title here - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://services.know-center.tugraz.at:8080/InteractiveOntologyQuestionnaire/
Google
Click here to start the interactive ontology questionnaire

Figure 1

Click on the link “Click here to start the interactive ontology questionnaire”.

1.2.2 Upload your domain ontology on

Upload the domain ontology for which you want to verify the inferences.

Figure 2

Click on “Browse” to open a file dialogue and browse for your ontology-file. Click on “Upload” to upload it.

Aposdle-Specific

If XXX is a prefix like “EADS”, “ISN” and so on for your company, this file is called “XXXdomain-ontology.owl”. If you do not know where you can find it, ask your coach for it.

1.2.3 Navigation

The header of the page shows the following entries:

- Upload Ontology
- List Entailed Statements
- Justification
- Save current ontology
- List Removed Axioms
- Options

These are the different views of the ontology. At every point in time, the views that are open to you are displayed as links. Click on them to go there.
A plain-text-view is either closed to you or you are currently seeing it.

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1.2.4 List inferred statements

You will automatically be transferred to the “List Entailed Statements”-View.

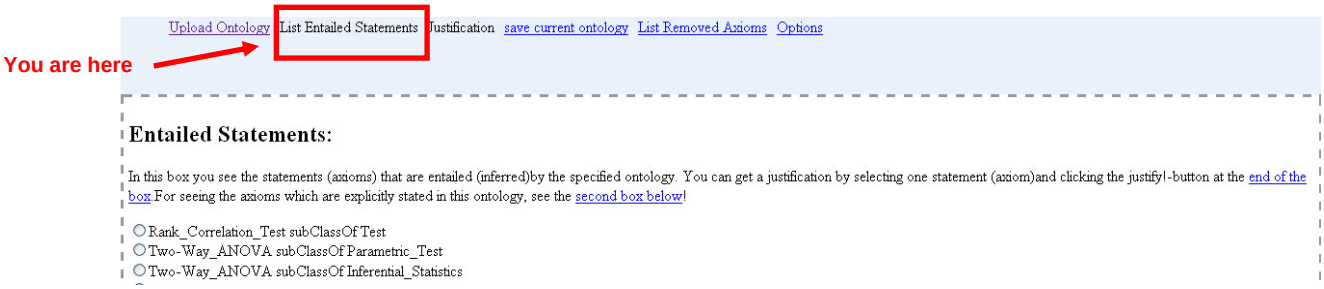
You are here
Upload Ontology
List Entailed Statements
Justification
save current ontology
List Removed Axioms
Options
Entailed Statements:
In this box you see the statements (axioms) that are entailed (inferred)by the specified ontology. You can get a justification by selecting one statement (axiom)and clicking the justify!-button at the end of the box For seeing the axioms which are explicitly stated in this ontology, see the second box below!
Rank_Correlation_Test subClassOf Test
Two-Way_ANOVA subClassOf Parametric_Test
Two-Way_ANOVA subClassOf Inferential_Statistics

Figure 3

On the displayed page, you see two boxes: One with the title “Entailed Statements” and one with the title “Axioms” (see Figure 4). We call the first the “Entailed Statements” – box and the second the “Explicit Statements” – box.
The first box shows the statements which are inferred from the uploaded ontology. If you open the *.owl-file with a text editor you would not find these statements written there.
The second box shows the statements which were explicitly given in the MoKi.

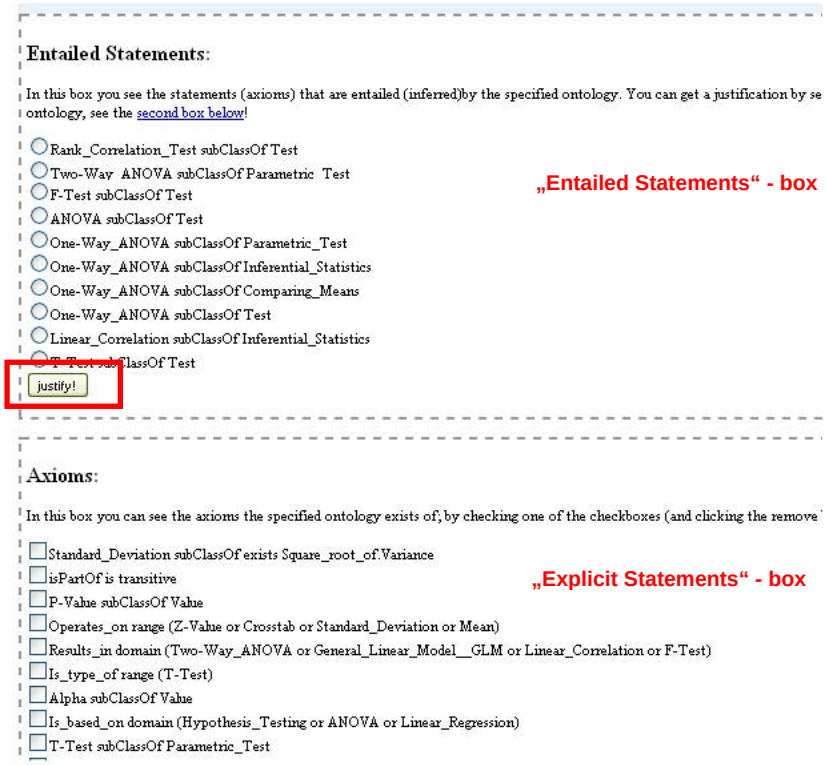
Entailed Statements:
In this box you see the statements (axioms) that are entailed (inferred)by the specified ontology. You can get a justification by se
ontology, see the second box below!
Rank_Correlation_Test subClassOf Test
Two-Way_ANOVA subClassOf Parametric_Test
F-Test subClassOf Test
ANOVA subClassOf Test
One-Way_ANOVA subClassOf Parametric_Test
One-Way_ANOVA subClassOf Inferential_Statistics
One-Way_ANOVA subClassOf Comparing_Means
One-Way_ANOVA subClassOf Test
Linear_Correlation subClassOf Inferential_Statistics
justify!
„Entailed Statements“ - box
Axioms:
In this box you can see the axioms the specified ontology exists of, by checking one of the checkboxes (and clicking the remove
Standard_Deviation subClassOf exists Square_root_of.Variance
isPartOf is transitive
P-Value subClassOf Value
Operates_on range (Z-Value or Crosstab or Standard_Deviation or Mean)
Results_in domain (Two-Way_ANOVA or General_Linear_Model__GLM or Linear_Correlation or F-Test)
Is_type_of range (T-Test)
Alpha subClassOf Value
Is_based_on domain (Hypothesis_Testing or ANOVA or Linear_Regression)
T-Test subClassOf Parametric_Test
„Explicit Statements“ - box

Figure 4

1.2.5 Find out the reason for an inferred statement and optionally delete it

If you want to know why a statement has been inferred, select the corresponding radio button and click the button “Justify” at the bottom of the “Entailed Statements” – box (see Figure 4).

You will be taken to the Justification – View (see Figure 5).

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In the first line you will see for which statement you are shown the reason. In the rose box you find one or more groups of statements. Each **group represents one reason** for the selected axiom.

- You can now simply **go back** to the list of entailed statements, or to another view.
- If you want to **delete the selected axiom** from the ontology you have two choices. You can not directly delete an inferred axiom, because it is not explicitly stated in the ontology. You can only remove the reasons why this axiom was inferred.
  - In the blue box there is a suggestion which axiom to remove. In order to accept this choice, click on the button “Delete Minimum Hitting Set”.

In the rose box you find one or more groups of statements. As each group represents one reason for the inferred axiom, you must remove one line from each group. You can do nothing wrong: the radio buttons ensure that you have selected one from each group. Click on the button “Remove” to remove all selected axioms.

Note that deleting axioms in the ontology does not change in any way your local ontology file! All changes are made on the server on a temporary model!

Note that after removing the reason(s) for the selected axiom you can go back to the “List Entailed Statements” – View and if you check, you should not find it in the list anymore.

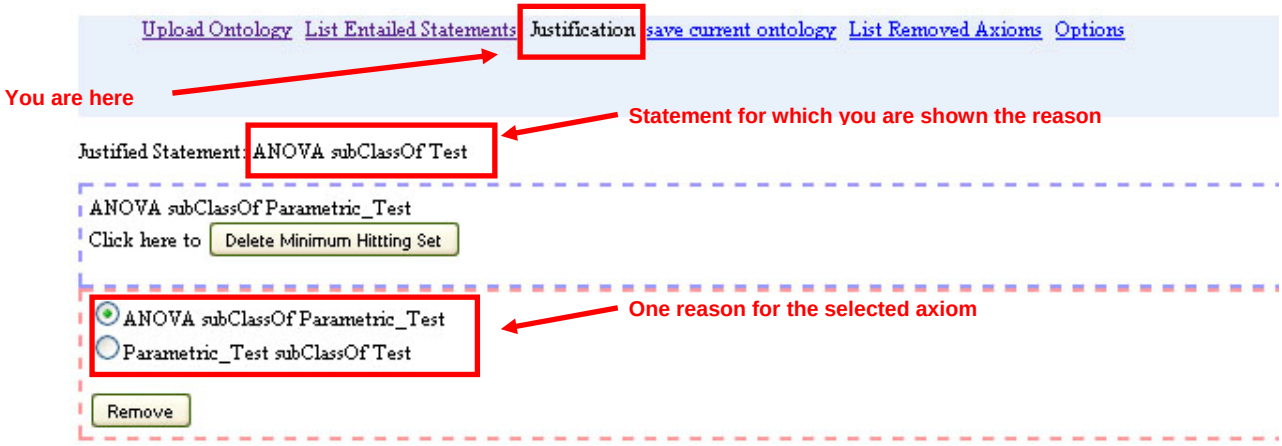

Figure 5

1.2.6 Undo and check which axioms you have already removed

Go to the “List Removed Axioms” – View.

You see a list of axioms / statements which you have removed from the ontology since you uploaded it to the questionnaire. By checking the checkbox in front of one or more axioms and then clicking “Reinsert!” you can add them again to the ontology, thus undoing your changes.

Aposdle – Specific

When you are finished with the questionnaire, i.e. when you have reviewed all inferred statements and are ready to assert the changes, go the the “List Removed Axioms” – View. For each axiom that is listed there: If it says “A subClassOf B”, then go to the concept page of the concept “A” in the MoKi. In the line “Is A” you should see the concept “B”. Edit the concept description and remove the concept “B”.
Please, for evaluation purposes, copy and paste the list of removed axioms into an email and send it to Viktoria Pammer (vpammer@know-center.at).

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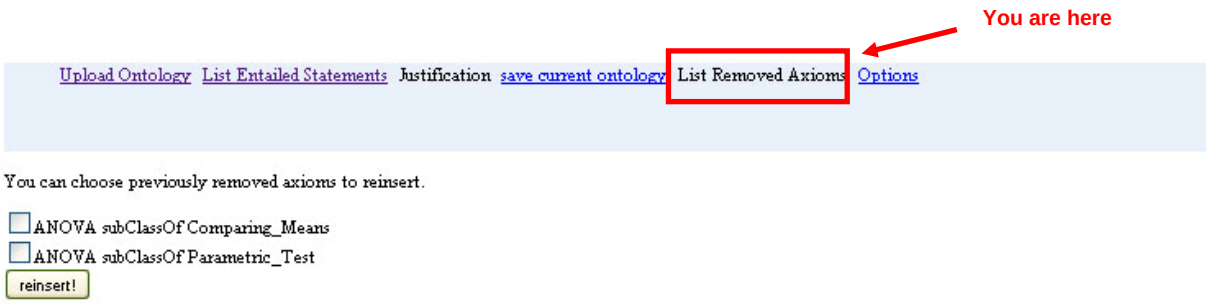

Figure 6

1.3 Additional features

1.3.1 Delete explicitly given statements

In the “Explicit statements” – box (see Figure 4) you see statements that were explicitly given in the ontology. If you decide you do not want to state this after all, you can simply check the checkbox corresponding to the statement and click on the “Delete” Button at the bottom of the box.

1.3.2 Save current ontology

In case you want to save the changed ontology to your local system, to to the “Save current ontology”-View. Depending on the browser you use, you will either be prompted directly to save the file or you will see a lot of text (RDF/XML) in the browser window. In this case, click on File and “Save As…” to save the ontology.

Note that the ontology questionnaire does not store labels, comments or similar things!

1.3.3 Options

In the “Options”-View you can (un)check the option “Use symbolic rendering engine”. After changing the selection you must click “Submit”.

If this checkbox ix checked, the statements will be shown as $ANOVA \subseteq Test$. If it is unchecked, statements will be shown as “Anova subClassOf Test”.

1.4 Known issues and bugs

The ontology questionnaire does not deal with imported ontologies. So if an ontology contains imports, the reasoning is done only over the statements within the uploaded file.

The ontology questionnaire does not store labels, comments or similar things.

The ontology questionnaire relies on Pellet to do the reasoning. If Pellet cannot deal with an ontology, the questionnaire cannot either. In case uploading an ontology takes too long, try loading the ontology into Protégé 4 and classifying it with Pellet. If this works, you have discovered a bug in the ontology questionnaire. If Pellet in Protégé 4 also fails, then this ontology can simply not be dealt with.

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Task-Competence Mapping Tool (TACT)

User Manual

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Executive Summary

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1 Preliminary Notes

With the TACT, we want to connect tasks with topics by specifying learning goals that are necessary for performing the tasks. This is a crucial step in the modelling process and therefore has to be performed carefully.

How do we define a "Learning Goal"?

We regard a learning goal as the combination of "Learning Goal Type" and "Topic". Thereby, the topic defines the content that the learning goal is about. The learning goal type specifies the type (or somehow the "degree") of knowledge (and skills) the person needs to have about this topic for performing a specific task.

For instance, a learning goal "basic knowledge about: APOSDLE Wiki" would describe the ability of a person to read and navigate in the APOSDLE Wiki. The person would know what is available on the APOSDLE Wiki, and how to move back and forth between the pages. The learning goal "basic knowledge about: APOSDLE Wiki" would not include the ability to edit the content of the Wiki, or to insert pages. In order to express the latter, a learning goal "know how to apply/use/do a: APOSDLE Wiki" would have to be defined.

A detailed description of how to build learning goals from topics, and a taxonomy of learning goal types are given in Section 2.

About this User Manual

With this manual, we want to give you some explanations and guidelines on what to keep in mind in order to obtain a meaningful and valid task-learning goal assignment.

The manual is organized as follows: At first, brief guidelines are given on how to model learning goals using the TACT (Section 2). Then, learning goal types are defined and explained by means of examples (Section 3). In Section 4, we gives a brief introduction about the how and why of using variables in tasks. Further, the guidelines from Section 2 are described in more detail (Section 5). In Section 6, the TACT tool and its features are described. Eventually, we have added a "lessons learned" section (Section 6) from our user test.

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2 Guidelines for specifying learning goals with the TACT

Some brief preparation will make the task-learning goal mapping much easier for you, and will notably enhance the quality of the resulting task-learning goal model.

Before starting the task-learning goal-assignment:

- Carefully read through the TACT User Manual. Make sure that you have a clear understanding of the meaning of the different **learning goal types**.
- Quickly skim through the list of **topics**, in order to have a "full picture" of which topics are modelled in your domain
- Quickly skim through the list of **tasks**. Maybe you don't remember how exactly you modelled your tasks (especially because you probably did a lot of revisions and cannot exactly remember the "final version"). Try to bring to mind what you meant by each task. Take a closer look at similar tasks, and think of the differences between them. This shall help you avoiding double work when using the TACT.

Assigning tasks and learning goals:

1. Assign to a task ALL learning goals that are INDISPENSABLE, and DO NOT ASSIGN learning goals that are only "nice to have" for performing the task
2. Assign to a task learning goals for all topics and SUB-TOPICS that are required for performing the task. Sub-topics are not inherited from their "parent"-topics.
3. DIFFERENTIATE between learning goals referring to the same topic by using different learning goal types
4. DO NOT RELY on the task-topic-assignment that stems from the "knowledge required"-section in the APOSDLE Wiki
5. Perform a SECOND TRIAL to review the task-learning goal assignment

Do first-cut task-learning goal mappings quickly, and rather by intuition without thinking too much, and do not strive for perfection. In a number of case studies, this strategy has proven to lead to success. WHEN YOU ARE FINISHED with a first-cut mapping for all tasks, walk through all task-learning goal assignments a second time, and, if necessary, add and remove learning goals.

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The first trial of your task-learning goal assignment **will take around 2 and 3 hours** (depending on the number of tasks in your model). The **revision will take another 60 min** approximately.

In Section 5, these points are explained in more detail.

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3 Building Learning goals with Learning goal Types

This document describes the learning goal types that are used in the third APOSDLE prototype. Each learning goal consists of one learning goal type and one topic. One topic can theoretically be linked with all five learning goal types, thereby creating five different learning goals.

Based on our experiences with the second prototype we revised the list of learning goal types. The remaining specific learning goal types are the following: “basic knowledge about”, “profound knowledge of”, “know how to apply/use/do a”, and “know how to produce a”.

These specific learning goal types are used to define learning goals for topics. They have clear definitions and meanings that are described hereinafter. There are “qualitative differences” between learning goals of the different types, in the sense that different cognitive processes are involved, but there is no explicit hierarchy among them. Although learning goal types are clearly specified, in several cases the final decision on which learning goal type to choose resides in the knowledge engineer. Descriptions of the topics may provide useful information, and facilitate the selection of a learning goal type. In the current version of the TACT, if available, topic descriptions are displayed.

Moreover, in the third APOSDLE prototype, we have added a learning goal type that is called “unspecified”. This learning goal type can be used to express that a user, in order to perform the task, might need all kinds of information about the topic.

In the TACT interface, by default, a learning goal is always of type “unspecified” and has to be changed into a specific learning goal type manually. This procedure is described in Section 6.6.

Table 1: Learning Goal Types in different langugages

Learning Goal Type (English)	**Learning Goal Type (German)**
“basic knowledge about”	“Grundwissen über”
“profound knowledge of”	“Umfassendes Wissen über”
“know how to apply/use/do a”	“Anwenden können von”
“know how to produce a”	“Anfertigen können von”
“unspecified” [empty cell]	“unspezifiziert” [leeres Feld]

Note: The learning goal types are not intended to be “hierarchical”, i.e. for instance “profound knowledge of” a topic does not include “basic knowledge about” a topic. If one wants to express that a user, performing the task, should be provided with learning content in order to acquire both “basic knowledge”, and “profound knowledge”, then this has to be modelled explicitly.

The role of learning goal types and material uses in the third APOSDLE prototype

In the third APOSDLE prototype, the main purpose of learning goal types is filtering the list of resources provided by “APOSDLE suggests”. Learning goals of different type lead to different types of snippets, i.e. different information. For instance, the learning goal type “basic knowledge about” is linked to the material use type “definition”. This means, for instance, if a user selects the learning goal “basic knowledge about: databases”, s/he might receive snippets that provide him/her with definitions

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of databases. However, if s/he selects the learning goal “know how to produce a: database”, APOSDLE might provide him/her with information about constraints of databases.

Naturally, APOSDLE can only provide such content if resources (documents, multimedia) are available for the desired material uses.

In contrast to specific learning goal types, the learning goal type “unspecified” is linked to ALL material uses. For instance, if there is a learning goal that is called “[unspecified:] database”, a user selecting the learning goal will receive snippets of all types, i.e., examples for databases, definitions, guidelines, checklists, and all other snippets that are available for the topic.

3.1 “Basic knowledge about”

Definition:
The learning goal type “basic knowledge about” means that a worker needs basic knowledge about the topic under consideration, in order to perform the task successfully. Basic knowledge includes the knowledge about dates, names, events, places, prices, titles, major theories.

The learning goal type “basic knowledge about” does not include the ability to use, apply, edit, or transform a topic.

Example
For instance, “basic knowledge about: APOSDLE Wiki” does not include navigating in the Wiki, editing it, or creating links.

APOSDLE use case:
The learner who clicks on the learning goal wants to have basic knowledge about what a <domain element> is.

The knowledge worker has no or very limited knowledge about a topic and wants to have a basic understanding of it, or wants to check whether his basic knowledge is accurate (up-to-date). To reach this goal s/he searches for introductory texts about the topic, definitions, or examples.

Material use types:
introduction, definition, example - what

APOSDLE Examples

- “basic knowledge about: creativity techniques”**:** knowledge about various creativity techniques, and tools available
- “basic knowledge about: addresses”: knowledge that a company can have different addresses, knowledge about which different addresses a company can have, knowledge about different addresses of a company
- **“**basic knowledge about: REACH interest agents”: basic knowledge about organizations that exert political influence on the implementation of REACH
- “basic knowledge about: exceptions of REACH”: knowledge about substances that are not subject to the regulations of REACH
- “basic knowledge about: model”: knowledge about properties and elements of a various models, knowledge about different types of models required for simulation building

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3.2 "Profound knowledge of"

Definition
The learning goal type "Profound knowledge of" means to comprehend conceptual knowledge about the topic and its properties, and the relationships to other topics in that domain. This includes, for instance, understanding the indication of a certain method, or tool, knowing causes and effects of an error, or understanding the mechanisms of an engine.

Example
If, for instance, this learning goal type is linked to the topic "APOSDLE Wiki", the learning goal "profound knowledge of: APOSDLE Wiki" means that one understands the structure of the APOSDLE Wiki, the functionality of the icons, or that one is able to navigate in the Wiki.

APOSDLE use case:
The learner wants to have a profound understanding of a <domain element>

The knowledge worker has a basic understanding of a topic, but he still has questions like: OK, I know what it is, but how does this work? Why should I do it (in a certain way)? How did this happen? Why did this happen? S/he searches for explanations that help him to answer these questions.

Or s/he just wants to know more about the topic to be able to understand things s/he reads in documents, or to be able to communicate about the topic with co-workers or to be able to generate new ideas Therefore s/he searches for information that contains backspecialised information, historical data, trends and developments, relationships with other domain elements etc.

Material use types:
explanation, more about

APOSDLE Examples
- "profound knowledge of: scenario techniques": knowledge about the indication and principles of scenario techniques, understand how scenario techniques work, and why they work that way
- "profound knowledge of: relation": understand relations within a database system, knowledge about which data are linked to which other data, knowledge about properties of the relations
- "profound knowledge of: REACH substance class": understand the meaning of the classification of chemical substances in dependence on the date of registration, amount of input, toxicity, environmental compatibility and intended purpose
- "profound knowledge of: domain model": understand the data model of a certain domain, understand the structure, the purpose of structuring, and the logic of the data model

3.3 "Know how to apply/use/do a"

Definition
The learning goal type "know how to apply/use/do a" means to carry out procedural knowledge. Therefore, "know how to apply/use/do a" has to be linked only to topics that refer to a set of rules, or guidelines (e.g. a computation rule, the UML notation), procedures (e.g. the RESCUE requirements engineering process), a method (e.g, Systematic Interview), or a tool (e.g., Protegé).

"Know how to apply/use/do a" is used, when a procedure/method exists. The learning goal type can be used with methods, formats, applications, calculations, etc.

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Example:
If this learning goal type, for instance, is linked to the topic “Card Sorting” (a special knowledge elicitation technique), the learning goal “know how to apply/use/do a: Card Sorting” means to know how to do conduct a Card Sorting session with domain experts, how to prepare Card Sorting sessions, and how to log the results. However, “Know how to apply/use/do a: card sorting” does not mean to know in which situation Card Sorting is indicated, or which are advantages and disadvantages of the technique. Therefore, the learning goal type “Know how to apply/use/do a” does not include “Basic knowledge about” or “Profound knowledge of” a certain topic.

APOSDLE use case:
The learner wants to know how to apply/use/do a <domain element>

The knowledge worker wants to know what the (next) steps are in a procedure or a well defined task that s/he has to perform, but that s/he is not able to carry out without some guidance. S/he searches for information that tells him which steps there are and which order they have to be completed. This information is like a recipe or prescription. Furthermore, s/he likes to have an example or demonstration of the procedure.

Material use types:
how do I, demonstration, checklist, example – how

APOSDLE Examples
- “Know how to apply/use/do a: core learning goal analysis”: ability to perform a core learning goal analysis for a company;
- “Know how to apply/use/do a: Er2”: ability to use the text data format er2 for loading data into another data base system
- “Know how to apply/use/do a: MS Project”: ability to use the specific project management tool for project management, gantt charts, resource planning, etc.
- “Know how to apply/use/do a: substance fixtures”: ability to perform a survey of chemical substances in use

3.4 “Know how to produce”

Definition
The learning goal type “Know how to produce” means to be able to create, produce, or build a certain topic, for instance a “task model”. In this sense, “know how to produce” means the ability of a person to achieve a certain outcome without a specified rule or procedure. Therefore, “know how to produce” has to be linked to topics that refer to results (e.g., project report), or products (e.g., build a software).

Example
If this learning goal type is linked to a topic, for instance “Wiki content”, the learning goal “know how to produce: Wiki content” means that a person knows the Wiki setup and notation, and is able to edit the Wiki content. In this case, “profound knowledge of: Wiki content” is a prerequisite of “know how to produce: Wiki content”, and therefore a task that requires the learning goal “know how to produce: Wiki content” would also require the learning goal “profound knowledge of: Wiki content”. However, this is no general rule.

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The decision whether the ability to edit the content of the Wiki is specified by the learning goal “know how to produce: Wiki content” or “know how to apply/use/do: APOSDLE Wiki” is on the knowledge engineer, and depends on whether there are clear rules or procedures for creating the Wiki (know how to apply/use/do) or not (know how to produce).

APOSDLE use case:
The learner wants to know how to produce a <domain element>

The knowledge worker has to produce something that is not clearly defined but has some constraints (for example: a plan, an agenda for a meeting, a design) and wants to know what he has to keep in mind when performing such a task. He searches for lessons learned by others like guidelines, checklists, templates, examples and/or constraints that give some structure in performing the task without giving a recipe or prescription.

Material use types:
guideline, checklist, template, example – how, constraint

APOSDLE Examples

- “know how to produce: final report”: ability to write a final project report for the customer, includes the knowledge of standards and norms for layout, organization, references, etc.
- “know how to produce: scenario”: ability to generate simulation scenarios that enable identifying the major entities that must be represented by a simulation
- “know how to produce: REACH material for external consulting”: ability to generate documents which the IHK employees can hand on to the costumers during the consulting process

3.5 “unspecified”

Definition
The learning goal type “unspecified” is used to express that the task under consideration requires all kinds of knowledge about a certain topic.

Example:
For instance, if there is a learning goal that is called “[unspecified:] wiki”, a user selecting the learning goal will receive snippets of all types, i.e., examples of wikis, definitions, guidelines, checklists, and all other snippets that are available for the topic.

APOSDLE use case:
The learner wants to receive all snippets that are available for a specific topic.

Material use types:
All material use types

APOSDLE Examples
There are no specific examples – this type can be used for all types of topics

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4 Modelling more economically by creating tasks with variables

4.1 When and why could variables be useful?

Our modelling experiences have shown that very often the problem arises that a task, in different situations, requires different learning goals. For instance, consider the following example.

Example:

Consider the task "Prepare Agenda for Activity". The topic "Activity" in the domain model has a number of sub-topics (indentation is used to indicate the sub-class hierarchy):

Activity
- Meeting
- Board Meeting
- Demo Meeting
- Workshop

It is quite difficult to assign learning goals to the task "Prepare Agenda for Activity". For instance, preparing the agenda for a board meeting might require quite specific knowledge about board meetings (e.g. the learning goal "profound knowledge of: Board Meeting"), whereas it might require no knowledge at all about "Workshop". In contrast, preparing a workshop, of course, might require "profound knowledge of: Workshop", and no knowledge about "Board Meeting". Additionally, there might be knowledge that is required for performing the task "Prepare Agenda for Activity", independent of what is the "Activity", such as "know how to do/use/apply: Agenda".

This small example illustrates the fact that in some cases, tasks are modelled in a way that they might require knowledge independent of the concrete application of the task (e.g. "know how to do/use/apply: Agenda"), and knowledge that is strongly related to the concrete application of the task (e.g. "profound knowledge of: Board Meeting"). This could result in two different modelling decisions:

- **Ambiguous modelling**: a very generic topic is used modelled as a learning goal

  Example: The task "Prepare Agenda for Activity" requires the learning goal "basic understanding about: Activity", meaning that in a concrete situation (e.g. for preparing the agenda of a workshop) exactly one specific sub-topic of "Activity" (e.g. "Workshop") is required for performing the task. APOSDLE cannot deal with this ambiguity.

- **Detailed modelling:** the task is broken down into more specific tasks

  Example: The task "Prepare Agenda for Activity" is broken down into

  Prepare agenda for Meeting
  Prepare agenda for Board Meeting
  Prepare agenda for Demo Meeting
  Prepare agenda for Workshop

  Then, learning goals are assigned to these more specific tasks. However, this causes extra work for the knowledge engineer, as s/he needs to model all tasks separately, and as s/he needs to assign the knowledge that is always required for preparing the agenda of an activity (e.g. "know how to do/use/apply: Agenda") to each of these more specific tasks by hand.

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The disadvantages of these two ways of modelling should be overcome by using task variables.

4.2 The idea of tasks with variables

Tasks with variables (also called "parameters") are introduced for allowing knowledge engineers to model tasks in a compact manner (i.e., without forcing them to specify too many specific tasks). Nonetheless, APOSDLE users will obtain information about specific tasks that they need in realistic learning situations.

For example, the knowledge engineer creates the abstract task "Prepare Agenda for Activity", and assigns general learning goals to the task (e.g. "basic knowledge about: Agenda"). Then s/he indicates that there are different "Activities" (i.e. the knowledge engineer defines the task variable), and that for each of the specific activities, the user needs to have "profound understanding of" the respective activity (i.e. the knowledge engineer defines the learning goal variable).
Consequently, using APOSDLE in the specific situation, the user will receive general information about the abstract task (e.g. "basic knowledge about: Agenda"), as well as specific information about the specific task. For instance, s/he will receive information about what is a demo meeting, but not the information about what is a workshop.

4.3 Ground tasks, abstract tasks, and specialised tasks

In order to deal with variables, different types of tasks have to be defined. Normal tasks without variables are "ground tasks". Tasks with variables are called "abstract tasks" and tasks created from tasks with variables are "specialised tasks".

Ground task: A ground task is a task without a variable. For example "Prepare Agenda for Activity" is a specialised task.

Abstract task: An abstract task is a task with a variable that is about a certain topic (such as "Activity") with sub-topics in the domain model. Variables are denoted using "< >". For instance, the task "Prepare Agenda for <Activity>" is an abstract task that contains the variable <Activity>.

Specialised task: A specialised task is the instance of an abstract task. An abstract task is de-composed into specialised tasks by replacing the variable with all sub-topics of the topic that the variable is about.

Example:

The abstract task "Prepare Agenda for <Activity>" from the example above is a placeholder for the set of specialised tasks

Prepare agenda for Meeting
Prepare agenda for Board Meeting
Prepare agenda for Demo Meeting
Prepare agenda for Workshop

4.4 Where do variables come from

There are two ways to define variables:

(a) Task variables are defined in the MOKI

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(b) Task variables are defined in the TACT

In case of (a), namely the task variable has been defined in the MOKI, TACT will indicate that the task has a variable (see Figure 6-5 in section 6.7).

The technical description of how to model tasks with variables with the TACT tool is given in section 6.7 (e.g. see Figure 6-4).

In both cases, a variable can only be added if the following conditions are satisfied:

- The task has no other variable. Task names can contain at most one "variable".
- The topic has sub-topics (otherwise the variable makes no sense)
- The name of the topic occurs in the name of the task.

If you want to add a variable with TACT, the tool will check these conditions, and enable the "Add Variable" button only in case the conditions are satisfied.

4.5 Creating tasks with variables

The technical description of how to model tasks with variables with the TACT tool is given in section 6.7. In this section we describe what happens if a variable is added to a task.

Let us again consider the example from above. The knowledge engineer has modelled the abstract task "Prepare Agenda for <Activity>", where "Activity" is the task variable. Then, learning goals are assigned to the task. All topics from the ontology can be manually assigned to the task as learning goals. Moreover, some learning goals are created automatically.

Automatically created learning goals for abstract tasks:

Once a task with a variable is defined and selected in the TACT, TACT assigns to that abstract task an abstract learning goal, i.e. a learning goal with the same variable as the task. In our example, the abstract learning goal "[unspecified:] Activity" is created for the task "Prepare Agenda for <Activity>". This automatically created learning goal is a placeholder for specific learning goals of all specialised tasks related to the abstract task. Abstract learning goals can only be deleted by deleting the variable.

A second learning goal is automatically assigned to the task, namely a specialised learning goal that is about the domain topic which is the variable in the task. This automatically created learning goal in the example from above would be "[unspecified:] Activity", meaning that performing the task "Prepare Agenda for Activity", in any case, might require knowledge about "Activity" in general. This learning goal can be deleted.

The learning goal types of the two automatically created learning goals can be modified manually.

Specialised tasks inherit learning goals from abstract tasks

Each abstract task is split into specialised tasks, e.g the task "Prepare agenda for <Activity>" is decomposed into

Prepare agenda for Meeting
Prepare agenda for Board Meeting
Prepare agenda for Demo Meeting
Prepare agenda for Workshop

The task-learning goal mapping from abstract tasks is inherited each specialised task.

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For instance, consider the task-learning goal mapping for the abstract task

“Prepare agenda for <Activity>”

- “[unspecified:]: <Activity>” (automatically created, abstract learning goal)
- “profound knowledge of: Activity” (automatically created, specialised learning goal)
- “know how to apply/use/do: Agenda” (manually created learning goal)

The specialised task “Prepare agenda for Workshop” inherits the task-learning goal assignment:

“Prepare agenda for Workshop”

- “[unspecified:]: Workshop” (automatically created from abstract learning goal)
- “profound knowledge of: Activity” (automatically created, specialised learning goal)
- “know how to apply/use/do: Agenda” (inherited from the abstract task)

Note: To each specialised task additional learning goals can be added (e.g. “basic knowledge of: Management”), but inherited learning goals cannot be deleted.

As the origin of learning goals (automatically created, manually created) might be confusing to the user of the TACT, we have added explanations that can be accessed clicking on the “Explanation”-button next to the learning goal of a task. These explanations are detailed in section 6.8.

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5 Description of Guidelines for specifying learning goals with the TACT

The guidelines that were introduced in section 2 are described in more detail hereinafter.

1. *Assign to a task ALL learning goals that are INDISPENSABLE, and DO NOT ASSIGN learning goals that are only "nice to have" for performing the task*

   The easiest this is done by imagining several concrete situations where a person performs the task. Then assign all learning goals that are required in ALL those situations.

   Example:

   The ISN task: "Detecting methods and tools" would definitely always require knowledge about which different methods and tools are available. Therefore, the learning goals that are indispensable for the task could be "basic knowledge about: methods", and "basic knowledge about: tools".

   Of course it might also be convenient for the person to have "profound knowledge of: methods", and "basic knowledge about: tools". The knowledge engineer has to decide whether these learning goals are indispensable for performing the task, or if they would be just "nice to have".

   The distinction between indispensable and dispensable learning goals is important, since modelling learning goals that are just "nice to have" will impair the selection of adequate learning content in a concrete APOSDLE application.

2. *Assign to a task learning goals for all topics and SUB-TOPICS that are required for performing the task. Sub-topics are not inherited from their "parent"-topics.*
   If you want to express that a task requires knowledge about all sub-topics of a certain topic (e.g. all sub-topics of "MS Office" in your domain model, namely "MS Word", "MS Excel", and "MS Power Point"), this has to be modelled explicitly. In other words, assigning the learning goal "basic knowledge of: MS Office" does not include "basic knowledge of: MS Word", or "basic knowledge of: MS Excel".

3. *DIFFERENTIATE between learning goals referring to the same topic by using different learning goal types*

   Specify learning goals by using diverse learning goal types. For instance, the EADS-task "Validate and test simulation" might require diverse learning goals relating to the topic "Simulation Software". First, the worker might need to have "basic knowledge about: Simulation Software", i.e. she needs knowledge about the software. Second, the worker might also need to have "profound knowledge of: Simulation Software". Finally, she might have to "Know how to apply/use/do a: Simulation Software".

   In another task, e.g. "Define the software and hardware architecture", the worker might only need "basic knowledge about: Simulation Software", and "profound knowledge of: Simulation Software" but she might not need to apply it.

4. *DO NOT RELY on the suggested topics that stem from the "knowledge required"-section in the APOSDLE Wiki*

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The “knowledge required” section of the APOSDLE Wiki was filled in a rather early modelling stage. Consequently those “suggested topics” might be incomplete, or some of them might be wrong.

Therefore, please take those topics only as “suggestions”, or “hints”, and do not hesitate to re-assess their relevance for performing the task. It is absolutely normal if you, as a knowledge engineer, will change your point of view, and your understanding of “required knowledge”. Modelling is an iterative process that requires revisions at certain stages.

5. *Perform a SECOND TRIAL to review the task-learning goal assignment*

Usually, at the beginning of a task-learning goal mapping one is rather unsure about how to do this. During modelling, a sense arises for what is a meaningful mapping and what not.

Therefore, do first-cut task-learning goal mappings quickly, and rather by intuition without thinking too much, and do not strive for perfection. In a number of case studies, this strategy has proven to lead to success. WHEN YOU ARE FINISHED with a first-cut mapping for all tasks, walk through all task-learning goal assignments a second time, and, if necessary, add and remove learning goals.

Especially, if two or more tasks have the same (or very similar) learning goals assigned, think about it once again.

The first trial of your task-learning goal assignment **will take around 2 and 3 hours** (depending on the number of tasks in your model). The **revision will take another 60 min** approximately.

Variables

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6 Using the TACT

This section provides you with technical information on how to install and use the TACT.

6.1 Installation

6.1.1 Prerequisite:

In order to use the TACT, you **must have Java 6** installed. Preferably, you have Java 6, Update 10, which allows you to see a slightly nicer User Interface..
In Windows, you can check this in the list of installed Software.

If you find that you do not have Java 6 installed, you can download it from Sun's homepage: http://www.java.com/de/download/manual.jsp.

6.1.2 TACT

The TACT distribution is located at

https://partner.know-center.at/KC_Partner_Space/Aposdle/01_WP%20Workspace/WP01_Process/Modelling%20Tools/TACT%20(P3).

Save the **tact.jar** File into a separate directory.

6.2 Your Knowledgebase: Files you need

XXX stands for CCI, EADS, ISN, RESCUE or SDA. The TACT will need to read the following files, so have them ready somewhere on your hard disk. They must all be in **one directory**.

- **XXXaposdle-ontology.owl:** Contains APOSDLE specific concepts, such as "Task", or "Learning Goal".
- **XXXaposdle-categories.owl:** Contains APOSDLE specific categories, such as learning goal types.
- **XXXdomain-ontology.owl:** Contains your domain model
- **XXXtask-ontology.owl:** Contains your task model
- **XXXknowrequ.txt**: This is optional. It contains the "knowledge required" that you defined in the MoKi for your tasks.

For each application partners, these files are in the svn-repository. Application partners: if you do not have access to the svn, please ask your coach about it.

6.3 Files that will be modified

When you save your work in TACT, **XXXtask-ontology.owl** will be modified.

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6.4 Files that will be created:

When you save your work in TACT, the following files will be created in the directory where the other knowledge base files are.

- **XXXtask-learninggoal-ontology.owl:** Contains the mappings between tasks and learning goals.
- **XXXlearninggoal-ontology.owl:** Contains the descriptions of the required learning goals.

These files are needed by FBK for storing in the Structure Repository, and we suggest adding these files to the subversion repository in the respective directories where the domain and task ontology are stored. Application partners: please send these files to your coach once you are finished with the TACT.

- **backup**: Directory that contains previous versions of your model. You can restore them by clicking the “Restore old data version” button in the opening dialog (see 6.5: Startup view of TACT).
- **temp\:**

The following files will be created in the directory where you saved tact.jar:

- **TACT.log:** A logfile. In case of problems with the TACT, send this logfile together with a clear and repeatable problem description to the Know-Center (vpammer@know-center.at)
- **TACT.properties**: Contains the last directory which you opened with TACT.
- **Diff.csv**: Contains a change-log. Please send this file to the Know-Center (bkump@tugraz.at) once you are finished with the TACT.

6.5 Startup view of TACT

1. Double-click tact.jar.

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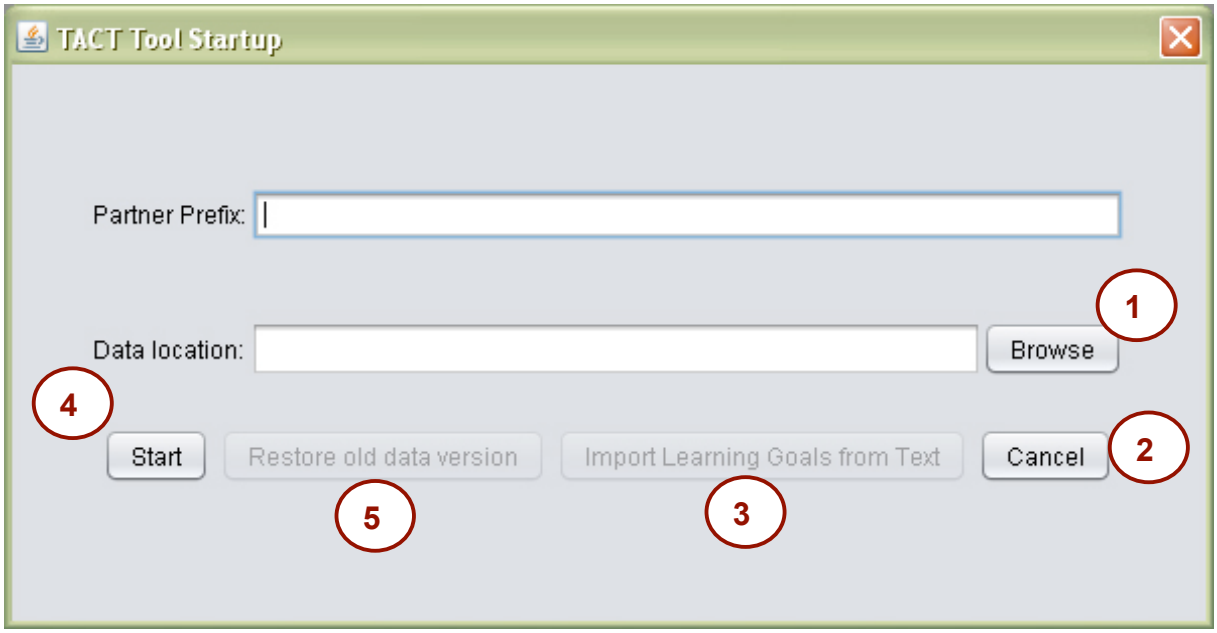

Figure 6-1 Start-up view on TACT

2. Click on the “Browse” button (1) and choose XXXaposdle-categories.owl file in the directory where your knowledge base resides.

If you want to import learning goals that you entered as “knowledge required” in the Moki, click on “Import Learning Goals from Text” (3).

Click “Start” (4) in order to start the TACT for the defined Knowledgebase. If you have imported learning goals from the MoKi as described in Step 3, then you will get a reminder to save all learning goals with the TACT in order to obtain the formal models (see Figure Figure 6-2).

3. When you have already worked with this Knowledgebase in TACT before, and have earlier versions, you can restore them by clicking on “Restore old data version” (5). Then choose the directory which contains the desired backup. The backup directories are labelled with dates, so you have one backup per day.

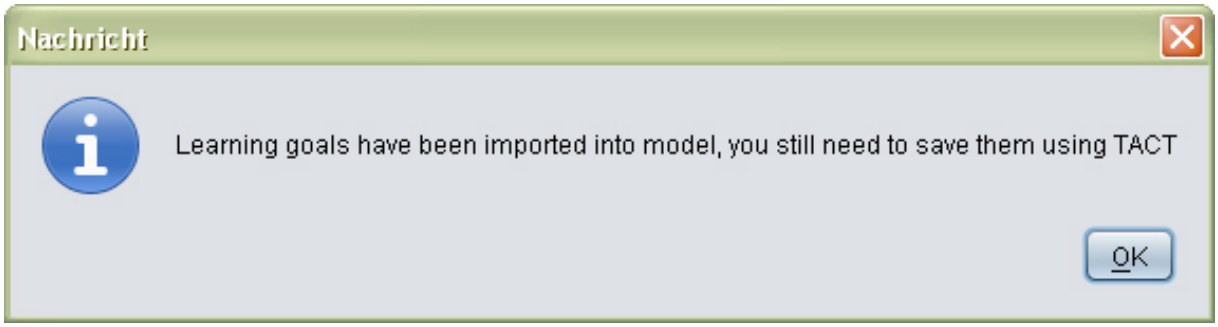

Figure 6-2: When learning goals from the MoKi are loaded using a text file, you still need to use the "Save" button in TACT in order to obtain the formal learning goal model

6.6 Creating the learning goal model, simple mode

This section describes the basic functionality of the TACT to create a learning goal models Most probably, this will be all you need.

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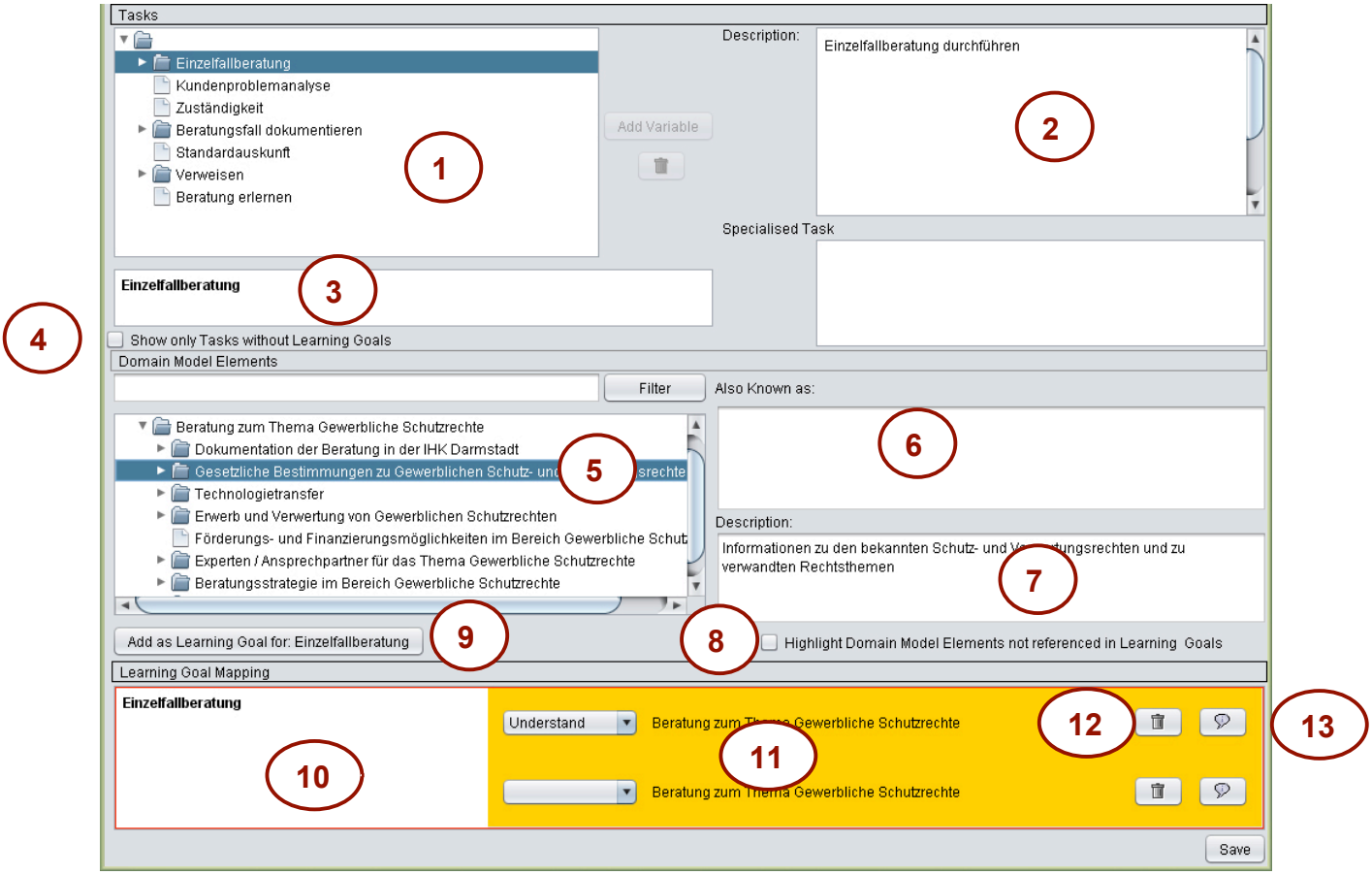

Figure 6-3 Overview of the TACT User Interface

On the top left you see the task browser. It shows the Sub-Task hierarchy (1). If you click on a task, you see its description, if you entered a description in the MoKi, on the right (2). You see the name of the selected task once again below the task browser (3).

If you want to see only those task to which no learning goals are yet assigned, mark the corresponding checkbox below the task browser (4).

4. In the middle on the left you see the topic browser. It shows the hierarchy of the topics according to the is-a hierarchy. If you click on a topic, you see its synonyms (6) and its description (7) to the right, if you entered them in the MoKi.

5. If you want to see only topics which are used to describe a learning goal, mark the corresponding checkbox below the topic description field (8).

6. If you want to add a learning goal to the selected task, select the topic that you want and click the “Add Learning Goal for <selected topic> Button (9).

7. At the bottom left you see the selected task again (10). To its right, you see the already assigned learning goals (10). The drop-down field shows the learning goal type, the text to its right shows the topic.

8. In order to assign to a task multiple learning goals about the same topic but with different learning goals, proceed as follows: Add a learning goal for the topic, its type is per default "Unspecified" (empty selection in TACT). Change its type. Then add the next learning goal, which is again created with the default type "Unspecified". Change its type etc.

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9. You can delete a learning goal by clicking on theTrash-Button (12), and you can get an explanation why the learning goal is here by clicking on the Explanation-Button (13). For more on explanations see Section 6.8.
10. The reason for this procedure is, that you can not assign two exactly equal learning goals (same topic, same type) to one task. TACT always creates the learning goal with the type "Unspecified" per default.
11. Click “Save” to store all your changes: Changes of learning goal types, new learning goals, removing old learning goals etc.

6.7 Creating the learning goal model, advanced mode with variables

This section deals with the possibility to add variables to tasks, and explains what happens technically in this case. The conceptual meaning of variables is described in Section 4.

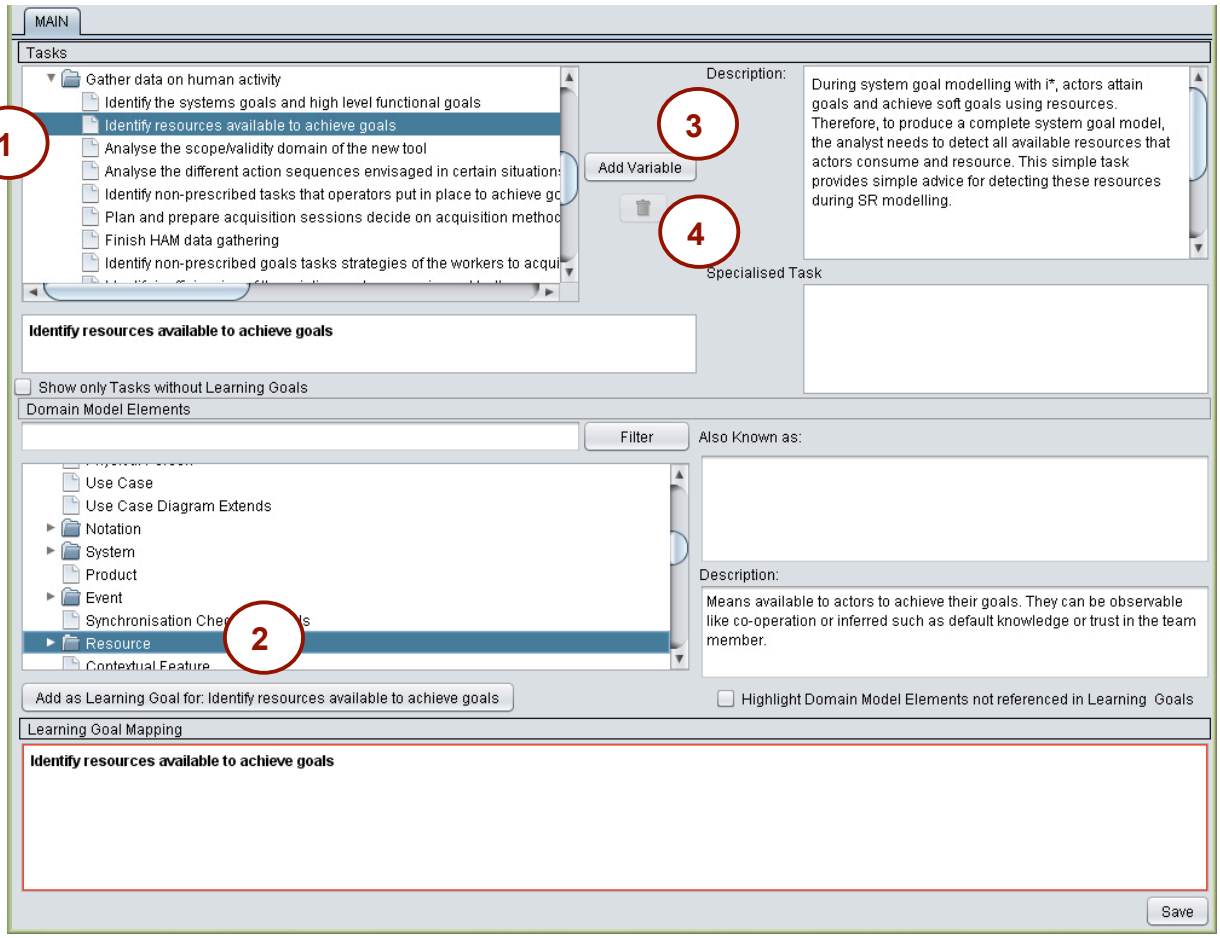
MAIN
Tasks
Gather data on human activity
Identify the systems goals and high level functional goals
Identify resources available to achieve goals
Analyse the scope/validity domain of the new tool
Analyse the different action sequences envisaged in certain situation
Identify non-prescribed tasks that operators put in place to achieve go
Plan and prepare acquisition sessions decide on acquisition method
Finish HAM data gathering
Identify non-prescribed goals tasks strategies of the workers to acqui
1
Description:
During system goal modelling with i*, actors attain goals and achieve soft goals using resources. Therefore, to produce a complete system goal model, the analyst needs to detect all available resources that actors consume and resource. This simple task provides simple advice for detecting these resources during SR modelling.
3
Add Variable
4
Specialised Task
Identify resources available to achieve goals
Show only Tasks without Learning Goals
Domain Model Elements
Filter
Also Known as:
Use Case
Use Case Diagram Extends
Notation
System
Product
Event
Resource
2
Description:
Means available to actors to achieve their goals. They can be observable like co-operation or inferred such as default knowledge or trust in the team member.
Add as Learning Goal for: Identify resources available to achieve goals
Highlight Domain Model Elements not referenced in Learning Goals
Learning Goal Mapping
Identify resources available to achieve goals
Save

Figure 6-4: Overview of the TACT, a variable can be added.

Select a task (1) and an appropriate topic (2)

a. A topic can be used as a variable if: The task has no other variable, the topic has sub-topics, and the name of the topic occurs in the name of the task.
b. TACT will only let you add a variable in these cases. In all other cases, the button “Add Variable” (3) is disabled.

12. Click the “Add Variable” Button (3).

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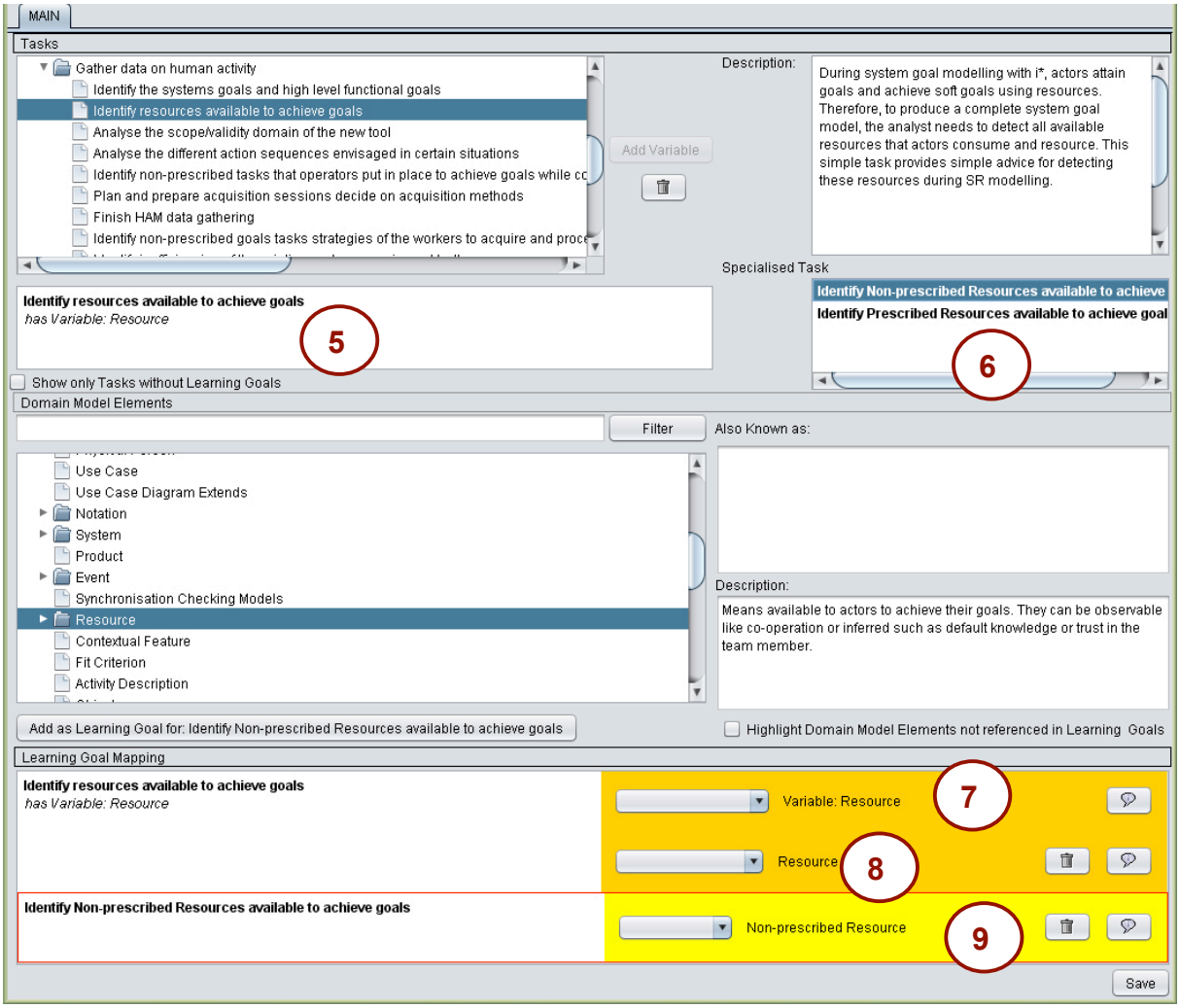
MAIN
Tasks
Gather data on human activity
Identify the systems goals and high level functional goals
Identify resources available to achieve goals
Analyse the scope/validity domain of the new tool
Analyse the different action sequences envisaged in certain situations
Identify non-prescribed tasks that operators put in place to achieve goals while cc
Plan and prepare acquisition sessions decide on acquisition methods
Finish HAM data gathering
Identify non-prescribed goals tasks strategies of the workers to acquire and proc
Add Variable
Description:
During system goal modelling with i*, actors attain goals and achieve soft goals using resources. Therefore, to produce a complete system goal model, the analyst needs to detect all available resources that actors consume and resource. This simple task provides simple advice for detecting these resources during SR modelling.
Specialised Task
Identify resources available to achieve goals
has Variable: Resource
5
Identify Non-prescribed Resources available to achieve
Identify Prescribed Resources available to achieve goal
6
Show only Tasks without Learning Goals
Domain Model Elements
Filter
Also Known as:
Use Case
Use Case Diagram Extends
Notation
System
Product
Event
Synchronisation Checking Models
Resource
Contextual Feature
Fit Criterion
Activity Description
Description:
Means available to actors to achieve their goals. They can be observable like co-operation or inferred such as default knowledge or trust in the team member.
Add as Learning Goal for: Identify Non-prescribed Resources available to achieve goals
Highlight Domain Model Elements not referenced in Learning Goals
Learning Goal Mapping
Identify resources available to achieve goals
has Variable: Resource
Variable: Resource
7
Resource
8
Identify Non-prescribed Resources available to achieve goals
Non-prescribed Resource
9
Save

Figure 6-5: A task with a variable is selected. Specialised tasks are shown.

Now the selected task is shown to have a variable (5). Also, a number of specialised tasks are created (6). For each subtopic of the variable, one specialised task is created. Each specialised task specialises the task with the variable with respect to one subtopic of the variable. For instance if “Resource” is the variable and “Non-Prescribed Resource” is a subtopic, the task “Identify Non-Prescribed Resources…” specialises the task “Identify Resources …” with respect to “Prescribed Resource”.

Two learning goals are automatically added to the task with the variable (7), (8). The first learning goal, (7) contains the same variable as the task. This learning goal can only be deleted by deleting the variable. The meaning of this learning goal is, that each specialised task will require a learning goal for the subtopic with respect to which it specialises the task with the variable. For instance the task “Identify Non-prescribed Resources…” will automatically require a learning goal with the topic “Non-prescribed Resource” (9). You can not delete this learning goal!

The second learning goal is a “normal” learning goal for the topic (8). This learning goal can be deleted.

Special notes:

- Note that **a specialised task inherits all learning goals** of the task with the variable! Therefore, add all learning goals that all specialised tasks require only once to the task with the

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variable, and only additional learning goals required only by one specialised task to this specialised task.

- Once you have selected a specialised task, you must **unselect** it to add learning goals to the corresponding task with the variable. Do so by holding the “Ctrl” Key of your keyboard and then clicking again on the selected specialised task.

6.8 Explanations for learning goals

Since a number of learning goals are added automatically, TACT provides you with explanations for why a learning goal appears next to a task.

1. **This learning goal was created manually in the current session**
   You manually added this learning goal since you have opened the current Knowledgebase with the TACT.
2. **This learning goal was imported from an existing learning goal model**.
   When you opened the TACT, this learning goal was already contained in the previous learning goal model. It may have been that this learning goal was imported from text, from the knowledge required in the MoKi. Another case is, that you saved your learning goal model one day, and reopened the same Knowledge Base another day.
3. **This learning goal was created automatically and contains the same variable as the task.**
   This learnig goal contains a variable. It is the same variable as the corresponding task. All specialised tasks will get a learning goal with the corresponding subtopic of the variable. You cannot delete this learning goal, except if you delete the variable.
4. **This learning goal was created automatically and contains the topic of the variable in the task.**
   This learning goal is a normal learning goal, which contains the topic of the variable. It is assigned to the task with the variable. This learning goal was added based on a heuristic. You can delete it.
5. **This learning goal was created automatically and contains a sub-concept of the variable in the task.**
   This learning goal is assigned to a specialised task. It contains a subtopic of the variable, namely the subtopic with which the specialised task specialises the task with the variable. You can not delete this learning goal, except by removing the variable. This however will also remove the specialised task.

6.9 Trouble Shooting

6.9.1 Unselecting elements

In order to unselect any element, hold down the “Ctrl” key on your keyboard and click on the selected element.

6.9.2 Different ontology, task-ontology, or required-knowledge files

If you want to do the mapping with a different domain ontology or a different task ontology.

- Close the TACT
- Open it again, and choose the Knowledgebase that you want to open.

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7 FAQ and Lessons Learned

Some questions were arising and some lessons were learned during our user tests…

FAQ

- Why do some topics occur twice in the topic browser?
  One and the same topic can be a sub-topic of two different topics. If two topics have the same name, they are one and the same topic and no distinction needs to be made between them.

- How many learning goals should be assigned to a task?
  All learning goals that are “mandatory” should be assigned to a task (don’t assign learning goals that would be “nice to have”). Learning goals are not “inherited” from “supertasks” or tasks that have to be performed **before** the task under consideration, but have to be modeled explicitly. The easiest this is realized by asking for each task: What do I have to know/be able to do for performing the task successfully?

Lessons Learned

- Use variables sparingly. Otherwise, the number of tasks can easily become very large.

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Project Number **027023**
APOSDLE: Advanced Process Oriented Self-Directed Learning Environment
Integrated Project
IST – Technology enhanced Learning

Validation & Revision of Learning Goals

Integrated Modelling Methodology

APOSDLE Identifier	APOSDLE-W10-JRS-Agenda-Plenary-and-GA-Trento
Author / Partner	Chiara Ghidini / FBK Barbara Kump / TUG Marco Rospocher/FBK
Work Package / Task	WP I
Document Status	Draft
Confidentiality	Confidential

Version	Date	Reason of change
1	2008-10-1	Document created
2	2008-10-10	Distinction between manual and automatic cheks added
3	2008-10-11	Step on “questionnaire” added
4	2008-10-16	Document revised adding steps

1 Introduction

This document has the goal of guiding Application Partners and Coaches through a list of checks and suggestions to be used to refine and tune the models modified and/or created in TACT.

The changes of the models triggered by the list of checks and suggestions described here should be made in the MoKi and/or in TACT by the application partners supervised by their coaches.

In the following we provide a description of all the checks performed.

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2 Automatic checks

These checks will be performed automatically (ie via appropriate scripts). The results will be provided by FBK at the beginning of the revision process to the coaches. The coaches will send them to the Application Partners, and they together will coordinate on how to revise the models in the MoKi and/or TACT accordingly.

2.1 General Statistics

- Number of Tasks;
- Number of Domain Elements;
- Number of Learning Goals;
- Number of Task/Learning Goal Assignments;

These statistics are provided to give an overview of the size of the models created with the MoKi and TACT. They are not meant to emphasise errors or problems. Nevertheless if the numbers differ greatly (e.g. very few tasks, but a large number of learning goals) this may be caused by some granularity discrepancy and should be discussed with the coaches to check if this may originate problems in APOSDLE.

2.2 Connection between Task Model and Learning Goal Model

- **list of tasks without associated learning goals**: tasks should be associated to at least 1 learning goal. Please check the reason why there are tasks not related to any learning goal.
- **list of tasks with =1 associated learning goal**: If a task has only one learning goal assigned, this might have several reasons:
    - Performing the task requires only one learning goal. However, this should not be the case for too many tasks, because otherwise one of the models (task model, domain model is becoming redundant).
    - The task might be not central to the learning domain (it possibly requires a lot of other learning goals that are not modelled).
    - The task might be central to the learning domain. However, crucial learning goals are missing, because the domain concepts have been forgotten in the domain model.
    - The task might be central to the learning domain. However, crucial learning goals are missing, because there are no resources available.
    - The domain concept that the learning goal is about might be rather “high-level” – and sub-concepts were also “meant”

  Implications: the possible explanations should be looked at
    - the modeller has to take the decision whether the task should be removed, whether the domain model should be broken down, whether further domain concepts should be picked-up into the model or whether the status quo is satisfactory
- **list of tasks with >5 associated learning goals**: tasks should be associated to a reasonable amount of learning goal. Having a task associated to more than 5 learning goal could highlight a difference of granularity between the description of tasks and the one of learning goals

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which needs to be fixed. This is not an error in general but needs to be checked. [Coaches should provide support to this check]

- Maybe the tasks are really complex and need a lot of learning goals.
- Maybe the learning goals are rather low-level and detailed.
- Maybe the tasks are very high-level and abstract.

Implications: the possible explanations should be looked at

- it should be reconsidered if the task should be broken down. Maybe the task is a super-task in the task model.
- This is one way to improve the TASK MODEL (wrt. completeness)

- **list of tasks with the same set of learning goals**: if there are tasks that have exactly the same learning goals this could suggest to join, or to delete, tasks with this property.
- **list of learning goals not connected to any task**: learning goals should always be associated to a task. Therefore if there are learning goals not connected to any task this is an error and needs to be fixed.
- **list of learning goals connected to only 1 task**: If a huge number of learning goals are assigned only to one (few) task, the system has less information to discriminate between different learning goals, and in particular to know which learning goals are “pre-requisites”of others (that is which “simple” learning goals must be achieved first in order to achieve “more difficult” learning goals). This was a big problem for P2, because the pre-requisite between learning goals was computed from the task-learning goal assignment but should be less problematic this year as a different strategy is used to compute pre-requisites between learning goals. Therefore possible changes should be first discussed with the coaches.

2.3 Connection between Domain Model and Task Model

- **list of domain elements not connected to any task**: domain elements not connected to any task will never be used in selecting learning material starting from a task, but will only be used in the free search, or in the “Topic Selection” of APOSDLE Suggests. Moreover, they will not be part of the prerequisite relation, which orders the topics/learning goals in ones being pre-requisites of others. The results of this test should be considered to check if some of the domain elements not connected to any task are instead needed as knowledge required for some task.
- **list of domain concepts connected to only 1 task**: If a huge number of domain concepts are assigned only to one (few) task, the system has less information to discriminate between different learning goals, and in particular to know which learning goals are “pre-requisites”of others (that is which “simple” learning goals must be achieved first in order to achieve “more difficult” learning goals). This was a big problem for P2, because the pre-requisite between learning goals was computed from the task-learning goal assignment but should be less problematic this year as a different strategy is used to compute pre-requisites between learning goals. Therefore possible changes should be first discussed with the coaches.

2.4 Learning Goal Types

- list of never used learning **goal type**: this is not necessarily an error but should be checked.

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Integrated Modelling Methodology
- Collection of Feedback -

The goal of this questionnaire is to collect positive and negative feedback useful for the evaluation and improvement of the Integrated Modelling Methodology.
Please state your comments the way you prefer: you can provide feedback in form of short sentences and bulleted lists as well as more complex descriptions. Both formats are perfectly acceptable.

Note for APs: Please provide feedback only for the steps you have already completed.

Partner Name: CCI

1. Step 0: Scope & Boundaries and Resources Collection

The goal of this step is to define the scope and boundaries of the application domain to be modeled, and to gather some resources related to the application domain. The output should be a first, preliminary list of tasks (process scribble), a first list of domain concepts, and a collection of relevant learning resources.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in choosing a domain and collect the resources?*
- *Were the explanation given clear enough?*
- *Was the goal of the step completed after this step? Was there something missing?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:
1

Positive Experiences:
[ADD your comments here]
During this step we could resort to the experience from APOSDLE Prototype 2. We knew how the domain concepts and the list of tasks have to look like. CCI chose a new domain: *Information and Consulting on Industrial Property Rights*. We started with an intense iterative process of building graphical domain and task models. These were visualised as simple concept trees. Therefore we used Microsoft Visio's block

diagram stencils. This simple visualisation turned out to be very helpful for the discussions with the domain experts.
For the collection of relevant learning resource we resorted to the relevant documents given within the CCI's intranet and the CCI's homepage. We also searched for relevant documents in the World Wide Web. We could easily build a collection of relevant learning resources.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]
80 hours

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*
In our opinion the goals were fulfilled within this step. We had a simple hierarchical and completed domain model, which was easily to understand for the domain experts. We also had a tasks model which was concerted with the CCI's workflow and a great collection of relevant learning resources.

Please state the main **differences** (if any) between performing this step this year and last year:
We used both times the same methods.

2. Step 1a: Knowledge elicitation from Digital Resources

The goal of this sub-step is to extract as much knowledge as possible from the digital resources provided by the Domain Experts. The desired output of Stage 1a is a number of candidate domain concepts.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Was the knowledge elicited useful?*
- *What where the main difficulties encountered in eliciting knowledge from resources?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step? Was there something missing?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:

2

Positive Experiences:
[ADD your comments here]
We did not use a tool for terminology extraction, we extracted the knowledge from the digital resource intellectually. We analysed the structure of the resources and gathered a number of candidate domain concepts. It was not difficult, but it took a lot of time.

Negative Experiences:
[ADD your comments here]
This step took a lot of time.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]
60 hours

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*
We gathered many new domain concepts within this task. Because of reading and concerning with the resources we could gather many information about *Information and Consulting on Industrial Property Rights.*

Please state the main **differences** (if any) between performing this step this year and last year:
No difference, we used the same methods. We did not use the term extraction tool due to poor experiences with this tool last year.

3. Step 1b: Knowledge elicitation from Domain Experts (Des)

The goal of this sub-step is to elicit knowledge directly from the DEs. The desired output is a refined task list, and an extensive list of candidate domain concepts.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Did the domain experts coincide with the person performing the modeling?*
- *What where the main difficulties encountered in this stage?*

- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step (ie., was a refined task list, and an extensive list of candidate domain concepts ready after this step)?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:
2

Positive Experiences:
[ADD your comments here]
To gather the knowledge of our domain experts, we made several interviews and smaller workshops with them. These interviews were very comfortable and we got a lot of knowledge from them, so that we could gather new domain concepts. Again this step was not so difficult, but we spent a lot of time interviewing and observing the domain experts. The domain experts were this time more open for interviews and knowledge elicitation because they had a better understanding of the APOSDLE system and modeling process.

Negative Experiences:
[ADD your comments here]
Very time consuming. Difficulties to find the right dates. Unsolved problem: Experts' knowledge is expanding continuously. How could we transfer this knowledge growth to APOSDLE without repeating workshops and interviews continuously?

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]
50 hours

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*
We gathered a lot of domain concepts and also discussed the domain concepts made by the knowledge elicitation from Digital Resources. In our opinion we could build harmonious domain concept.

Please state the main **differences** (if any) between performing this step this year and last year:
We concentrated on one domain instead of two. Knowledge experts were stronger involved. No methodological differences.

4. Informal Modeling (of Domain and Tasks) in MoKi

Starting from the knowledge elicited in Step 1(a+b), the main goal of this step is to obtain an informal, but rather complete, description of the domain model and task model in a Semantic MediaWiki called MoKi. After this modeling step, the informal concept model should only consist of relevant domain concepts (see 5.2).

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Was the wiki used in a collaborative manner?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:
1

Experience with variables:

- *Did you use variables in the informal model? Please indicate why or why not.*
- *Did you find it difficult to understand how variables could be used in general?*
- *Did you find it difficult to insert variables in the MoKi?*

We did not use any variables. Our philosophy was to keep the models as simple as possible.

Positive Experiences:
[ADD your comments here]
Using the Sematic MediaWiki was not difficult. We could easily transcribe our domain concepts and the task model into the Wiki. The Sematic MeidaWiki was intuitive to use. The different illustrations of the domain concepts and the task model were very comfortable. We did not have any difficulties with this tool.

We did not use variables, because our domain model was not multidimensional. Using variables would have made our model disproportionally complicate.

Negative Experiences:
[ADD your comments here]
No negative expericences

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]
20 hours

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*
After this step we had all relevant domain concepts and tasks within clearly structured and transparent models.

Please state the main **differences** (if any) between performing this step this year and last year:

The MOKI has much improved since last year. It is as comfortable to use as Protégé.

5. Step 3: Informal Models Validation and Revision

The goal of this step is to have the domain model and task model validated (completeness and correctness) by the DEs. The step was supported by guidelines, by results from automatic checks and by an on-line ontology questionnaire.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:
0

Positive Experiences:
[ADD your comments here]
The tools were adequate for our domain model. We kept our models very simple: concept and task trees with some multihierarchies, no variables, no special semantic relations. Due to the simpleness and manageability of the models and thanks to the close contact to the domain expert we did not identify any further failures.

Negative Experiences:
[ADD your comments here]
We had to change all our is-part-of-relations into is-a-relations. This was no big workload because it was done automatically. But it would have been better if we knew from the beginning that the MOKI could only process is-a-relations and not the offered is-part-of-relations.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]
10 hours

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*
We discovered one or two minor mistakes. The check made us sure to have completed the informal model before going into the formal modeling phase.

Please state the main **differences** (if any) between performing this step this year and last year:
Last year the check found a lot of mistakes that had been caused by the deficits of the last version of the semantic wiki (old wiki: no separate wikis for the different ontologies → concept "project" was used by several ontology with different notion; wiki was quite confusing → many relations "knowledge required about" were missing etc.). The good check results are due to the improved MOKI:

6. Step 4: From Informal to Formal

At the end of this step, the domain model and task model will be contained in two OWL ontologies.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0
The OWL ontologies were made by an automatic export of the informal CCI domain an task models from the Semantic MediaWiki MoKi.

/

7. Step 5: Modelling of Learning goals (previously known as Formal Models Integration)

The goal of this step is to obtain an OWL ontology of the learning goal model via the TACT tool.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*

- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:

Experience with variables:

- *Did you use variables in the learning goals? Please indicate why or why not.*
- *Did you find it difficult to understand how variables could be used in general?*
- *Did you find it difficult to insert variables in TACT?*
- *If you used variables where did you find it more intuitive/easy to create tasks with variables: in the MoKi or in TACT?*

Positive Experiences:
[ADD your comments here]
Using the TACT tool was not difficult. The manual was very useful to understand the meaning of learning goal types and how to use the tool.

Negative Experiences:
[ADD your comments here]
We had problems in understanding the inheritance within the tool. We thought if a class has the learning goal type "profound knowledge about", the subclasses would inherit this learning goal type. This was not the case. So we had to define the learning goal type for every subclass although the class had already this learning goal type. This procedure took a lot of time.
Another difficulty was that our multihierarchies were not visible within the tool, although they were within the Semantic Media Wiki.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]
80 hours

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ?
The result looks reasonable in the TACT tool and in the ongoing CCIFormalModelsCheck.txt-file (even if the learning goal type "basic knowledge about" for the task "Beratung erlernen" has vanished in the check file). The true result will only be visible but in the APOSDLE prototype.

Please state the main **differences** (if any) between performing this step this year and last year:
The TACT tool has much more improved from the point of usability. Learning goal types are now clearer and more adequate for us.

8. Step 6: Formal Models Validation

At the end of this step, all the models created (domain, task and learning goals) should be formally correct and complete. The goal of this step is to have the models validated (completeness and correctness) by the DEs. The step was supported by guidelines, and by results from automatic checks similar to the one of step 3, but which also involve checking the quality of learning goals.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:
0 for a knowledge engineer. 5 for a domain expert who can not understand the CCIFormalModelsChecks.txt document.

Negative Experiences:
[ADD your comments here]
Can only be done by knowledge engineers and not by domain experts.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
3-4 hours

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

9. General questions and remarks

- Did the domain experts coincide with the person performing the modeling? If yes, did it happen in all the steps or only some?
  - No, domain experts and knowledge engineers were different persons in all steps of modelling.

- Do you think that the domain you have chosen is **appropriate** for learning support with APOSDLE?
  From the evaluation of APOSDLE prototype 2 CCI learned that the specific APOSDLE e-learning approach promises the highest benefits in a setting with
  - academic and scientific domains and users
  - solid domains and stable curriculums
  - a well maintained document basis
  - organisational culture rewarding one's own initiative, autonomy and self-monitoring.

  Neither the scenario of learning event organisation nor the scenario of learning consulting on REACH covered those requirements. Thus CCI changed the domain again and chose the new domain of *Information and Consulting on Industrial Property Rights*.
  The task of informing and consulting on industrial property rights is carried out by six people at CCI: two jurists, one electrical engineer, one economist, one biologist and one commercial clerk in case of substitution - academic qualification prevails. It is a stroke of luck that the economist person is still quite new in this task.
  The topic is well settled, well documented and manageable. Compared to REACH it is not very dynamic. CCI has got a clear profile in the domain: Unlike other consulting institutions like patent offices or industrial property agencies CCI informs especially on questions of patent strategy, patent commercialisation and licensing. CCI has built up genuine internal knowledge about property rights management for small and medium enterprises. Exactly this CCI genuine subject matter should be imparted to consulting novices with help of the APOSDLE system.

- Do you have any additional remarks or suggestions for improvement?
  - The modeling process is still very time consuming – this disadvantage has hardly changed. This can be accepted for a test situation but not for a "real world" application. Speed up modeling is crucial.
  - Modelling needs still a person with the qualification of a knowledge engineer. Modelling should be so easy that domain experts can do it themselves - knowledge engineering qualification is quite rare in small and medium sized companies.

Integrated Modelling Methodology
- Collection of Feedback -

The goal of this questionnaire is to collect positive and negative feedback useful for the evaluation and improvement of the Integrated Modelling Methodology.
Please state your comments the way you prefer: you can provide feedback in form of short sentences and bulleted lists as well as more complex descriptions. Both formats are perfectly acceptable.

Note for APs: Please provide feedback only for the steps you have already completed.

Partner Name: EADS IW

1. Step 0: Scope & Boundaries and Resources Collection

The goal of this step is to define the scope and boundaries of the application domain to be modeled, and to gather some resources related to the application domain. The output should be a first, preliminary list of tasks (process scribble), a first list of domain concepts, and a collection of relevant learning resources.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in choosing a domain and collect the resources?*
- *Were the explanation given clear enough?*
- *Was the goal of the step completed after this step? Was there something missing?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 3

Positive Experiences:
[ADD your comments here]

The EADS domain for P3 remained the same as for P2 and we have used the P2 version of models as a basis for P3 modeling activity.

Negative Experiences:
[ADD your comments here]

The major difficulty in EADS task and domain model building was:

- ➔ To represent all the complexity of Simulation domain in a task model limited to only one variable
- ➔ To have a domain model « readable » and understandable for the end user

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task: No redefinition of scope and no resources collection
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

The main difference was to use the P2 (models and domain) for P3 (and not beginning from scratch). The list of tasks and concepts for P3 were updated according to P2 evaluation results and new meta-model that enabled specifying an additional parameter in task model.

Moreover a questionnaire was filled by EADS. Its objective was to decide whether Simulation is an appropriate learning domain for APOSDLE P3.

About the scope of the domain, after the evaluation of P2, we decided to focus only on the development process of simulation and to "forget" the part concerning the study process.

2. Step 1a: Knowledge elicitation from Digital Resources

The goal of this sub-step is to extract as much knowledge as possible from the digital resources provided by the Domain Experts. The desired output of Stage 1a is a number of candidate domain concepts.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Was the knowledge elicited useful?*
- *What where the main difficulties encountered in eliciting knowledge from resources?*
- *Were the explanations given clear enough?*

- *Was the goal of the step completed after this step? Was there something missing?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 2

Positive Experiences:
[ADD your comments here]

As EADS domain for P3 remained the same as for P2, so the main starting basis we used were the P2 version of models and notes/remarks wrote during P2 evaluation.

Negative Experiences:
[ADD your comments here]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

3. Step 1b: Knowledge elicitation from Domain Experts (Des)

The goal of this sub-step is to elicit knowledge directly from the DEs. The desired output is a refined task list, and an extensive list of candidate domain concepts.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Did the domain experts coincide with the person performing the modeling?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*

- *Was the goal of the step completed after this step (ie., was a refined task list, and an extensive list of candidate domain concepts ready after this step)?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 2

Positive Experiences:
[ADD your comments here]

The evaluation of P2, both concerning the software and the EADS models created for P2, resulted in a kind of "knowledge elicitation from expert".

Negative Experiences:
[ADD your comments here]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

Same remarks as steps 0 &1a. The P2 evaluation included also model evaluation: Task-Learning Goal Mapping Evaluation meetings with simulation experts (Pierre and Richard P.), directly between KE and SE or with third party (Barbara) . This could be considered as "Knowledge elicitation from experts".

4. Informal Modeling (of Domain and Tasks) in MoKi

Starting from the knowledge elicited in Step 1(a+b), the main goal of this step is to obtain an informal, but rather complete, description of the domain model and task model in a Semantic MediaWiki called MoKi. After this modeling step, the informal concept model should only consist of relevant domain concepts (see 5.2).

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear? Yes*
- *Were the tools adequate? Yes*

- *Was the wiki used in a collaborative manner? No*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough? Yes*
- *Was the goal of the step completed after this step? Yes*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 2

Experience with variables:

- *Did you use variables in the informal model? Please indicate why or why not.*
- *Did you find it difficult to understand how variables could be used in general?*
- *Did you find it difficult to insert variables in the MoKi?*

Positive Experiences:
[ADD your comments here]

Very good support to KE in knowledge structuring and formalization
Some EADS internal document were prepared on task and domain model and were very useful to quicker the process
Better to have a separate MOKI for each partner
Useful Import functionality
Good visualization of tasks in dedicated 'tableau"
Useful "Is a" and "Part of " browser
Good manual user for the Moki
Use of variables in informal model:
-to reduce KE workload
-but limited to one due to potential complexity for visualization function
No strong difficulties to insert variables in the MOKI (usefull post checks)

Negative Experiences:
[ADD your comments here]

Deleted concepts that still remain available on the wiki
When creating them, difficult to have clear vision of how variables will be used further in the P3
There is missing the" moki to owl export" tool (this tool is interesting EADS)

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task: about 1 day (the preparatory document built before the MOKI , with some expert feedback, also strongly accelerate the modeling process)
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*

Yes. The models were quickly created and described on the MOKI .

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

Significant improvements were done for P3 informal modeling tool (MOKI) and process: template has been better organized and it was not necessary to KE to know the detailed Wiki syntax to enter data
KE was able to see the entire set of tasks (their description) with the learning goals (domain concepts)
Possibility to create groups of concepts and task with the very easy List typing
Each AP had his own MOKI

5. Step 3: Informal Models Validation and Revision

The goal of this step is to have the domain model and task model validated (completeness and correctness) by the DEs. The step was supported by guidelines, by results from automatic checks and by an on-line ontology questionnaire.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear? Yes*
- *Were the tools adequate? Yes*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough? Yes*
- *Was the goal of the step completed after this step?yes*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: **1** (no domain experts involved)

Positive Experiences:
[ADD your comments here]

The objective and explanation of this step was clear.
No DE involved but 2 KE
"Is a" and "part of" browser graphical tree representation participate in validation end revision
AUTOMATIC CHECK results very useful
No online ontology questionnaire used

Negative Experiences:
[ADD your comments here]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task: 2 hours
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*

Yes

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

Not so much differences

6. Step 4: From Informal to Formal

At the end of this step, the domain model and task model will be contained in two OWL ontologies.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear? Yes*
- *Were the tools adequate? Yes*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough? Yes*
- *Was the goal of the step completed after this step? Yes*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0 hour

Positive Experiences:
[ADD your comments here]

The KE was strongly supported by technology partners in formal models development. :
EADS owl model was provided by FBK.

Negative Experiences:
[ADD your comments here]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*

The answer concerns more the technology partners involved in the operation (necessary to look at the model in Protégé and to verify if nothing is missing after translation. But the method seems to be very satisfying. The only remark is that KE should have the possibility to export himself the MOKI's files in owl. Currently this function is not available for the KE.

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

No major differences

7. Step 5: Modelling of Learning goals (previously known as Formal Models Integration)

The goal of this step is to obtain an OWL ontology of the learning goal model via the TACT tool.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear? Yes*
- *Were the tools adequate? Yes*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough? Yes*
- *Was the goal of the step completed after this step? Yes*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 1

Experience with variables:

- *Did you use variables in the learning goals? Please indicate why or why not.*
  Not in tact because they have been defined int the MOKI
- *Did you find it difficult to understand how variables could be used in general?*
- *Did you find it difficult to insert variables in TACT?*
- *If you used variables where did you find it more intuitive/easy to create tasks with variables: in the MoKi or in TACT?*

Positive Experiences:
[ADD your comments here]

The installation and use of TACT tool is very easy and the user manual contains quite clear definitions and examples of the different competency types.

Negative Experiences:
[ADD your comments here]

The EADS simulation process is strongly iterative. The simulation engineer has always a possibility to go to the step before and revisit this step as a result of actions performed in later steps. Unfortunately we don't know exactly when he or she revisits a given task (before and after which task). It may have an impact on learning goals definition. The competencies are not the same if the simulation engineer performs a given task for the first time or for a second time.
For the Prototype 2 we decided to assign to the task all the learning goals that are relevant in both situations. However it means that the competency model contains several tasks with a great number of learning goals.
Of course TACT can be improved. As an example of possible improvements: the models visualization (identification of super tasks and subtasks, relations between concepts, presentation of process order instead of the alphabetical list of tasks).

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task: 8 hours
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]* *yes*

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

Better tool (TACT) but the process remains the same. The main difference consists in using variable in the task and learning goals definition.

8. Step 6: Formal Models Validation

At the end of this step, all the models created (domain, task and learning goals) should be formally correct and complete. The goal of this step is to have the models validated (completeness and correctness) by the DEs. The step was supported by guidelines, and by results from automatic checks similar to the one of step 3, but which also involve checking the quality of learning goals.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear? Yes*
- *Were the tools adequate? Yes*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough? yes*
- *Was the goal of the step completed after this step? Yes*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 1

The KE was strongly supported by technology partners in formal models validation. No DE involved

Positive Experiences:
[ADD your comments here]

AUTOMATIC post-TACT CHECK results very useful

Negative Experiences:
[ADD your comments here]

The answer concerns more the technology partners involved in the operation

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task: 1 hour
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer] yes*

Please state the main **differences** (if any) between performing this step this year and last year:

[ADD your comments here]

9. General questions and remarks

- Did the domain experts coincide with the person performing the modeling? If yes, did it happen in all the steps or only some?

No domain expert are not performing the modeling

- Do you think that the domain you have chosen is **appropriate** for learning support with APOSDLE? *[Please give reasons for your answer]*

Absolutely yes, role of "learning" is important especially within EADS IW. Finding, Applying and Creating new knowledge is part of Electromagnetic Simulation job. Target group expected to continuously learn / keep up to date with new developments. The simulation activities, as predictive and virtual-oriented capabilities, are more and more often used, to support numerous business activities. Broadly speaking, the training or learning management system should supports developing and maintaining the right range of skills and competences needed for the EM Simulation Domain 'jobs. Tasks that employees in the target group are performing are crucial to the success of success and safety of the products then as a consequence of the company!

- Do you have any additional remarks or suggestions for improvement?

Integrated Modelling Methodology
- Collection of Feedback -

The goal of this questionnaire is to collect positive and negative feedback useful for the evaluation and improvement of the Integrated Modelling Methodology.
Please state your comments the way you prefer: you can provide feedback in form of short sentences and bulleted lists as well as more complex descriptions. Both formats are perfectly acceptable.

Note for APs: Please provide feedback only for the steps you have already completed.

Partner Name: ISN

1. Step 0: Scope & Boundaries and Resources Collection

The goal of this step is to define the scope and boundaries of the application domain to be modeled, and to gather some resources related to the application domain. The output should be a first, preliminary list of tasks (process scribble), a first list of domain concepts, and a collection of relevant learning resources.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in choosing a domain and collect the resources?*
- *Were the explanation given clear enough?*
- *Was the goal of the step completed after this step? Was there something missing?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:
3

Positive Experiences:
[It is interesting to reflect the domain of the own company. Defining which domain can be useful, big enough but not too big it quite difficult, but interesting]

Negative Experiences:
[It would be good to have an APOSDLE with two domains, because we have one regarding the whole project processing of innovation management projects –in this field work mainly experts. But in our use case we plan also to have a general

APOSDLE for innovation management, where people from outside (costumers, students) can learn, without having access to the confidential documents]

Please **estimate your modeling efforts** at this stage in terms of hours spent to perform the task:
[0,5PM, 70h]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Yes, we did well designed Interviews with all domain experts and decided to take these parts for APOSDLE all of them agreed with]*

Please state the main **differences** (if any) between performing this step this year and last year:
[The experiences from last year were very useful. Last year we didn't spend so much effort in this step. We know know how APOSDLe and the models look like, also the experts knew how APOSDLE looks like…it is easier to define the scope and boundaries by knowing the system at least a little bit.]

2. Step 1a: Knowledge elicitation from Digital Resources

The goal of this sub-step is to extract as much knowledge as possible from the digital resources provided by the Domain Experts. The desired output of Stage 1a is a number of candidate domain concepts.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Was the knowledge elicited useful?*
- *What where the main difficulties encountered in eliciting knowledge from resources?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step? Was there something missing?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:1

Positive Experiences:
[It is very nice that the termextractor is now integrated to the MOKI. That makes it very easy to add the extracted concepts to the models]

Negative Experiences:
[There are some minor usability issues…uploading a document and then adding the topics to the ontology might not be very easy and intuitive for some users.
The termextractor still doesn't work very well with long or german documents – but it was sufficient for us]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[16h]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[It could be better. The results of the termextractor could still be improved.]*

Please state the main **differences** (if any) between performing this step this year and last year:
[It was easier to upload the documents to extract the terms and then to add the terms to the ontology]

3. Step 1b: Knowledge elicitation from Domain Experts (Des)

The goal of this sub-step is to elicit knowledge directly from the DEs. The desired output is a refined task list, and an extensive list of candidate domain concepts.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Did the domain experts coincide with the person performing the modeling?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step (ie., was a refined task list, and an extensive list of candidate domain concepts ready after this step)?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 3

Positive Experiences:
[We performed together with our Coach four very nice workshops using sophisticated knowledge elicitation techniques.After these workshops we had a lot of useful data]

Negative Experiences:
[It is a challenge to reduce the data from the domain experts to tasks and concepts…also it is not very easy to find overlaps: Each DE has his own view on the things and his own view on how important some things are]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[1 PM, 140 h]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Yes, the data was very useful]*

Please state the main **differences** (if any) between performing this step this year and last year:
[Last year we didn't spend much effort in this step, the problem is that I assume that the quality of the models depend highly from this step]

4. Informal Modeling (of Domain and Tasks) in MoKi

Starting from the knowledge elicited in Step 1(a+b), the main goal of this step is to obtain an informal, but rather complete, description of the domain model and task model in a Semantic MediaWiki called MoKi. After this modeling step, the informal concept model should only consist of relevant domain concepts (see 5.2).

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Was the wiki used in a collaborative manner?*
- *What where the main difficulties encountered in this stage?*

- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0

Experience with variables:

- *Did you use variables in the informal model? Please indicate why or why not.Yes we did use variables. We have some Concepts e.g Creativity Techniques, which has about 15 Subconcepts labeling different techniques. Therefore it really makes sense to use these variables.*
- *Did you find it difficult to understand how variables could be used in general?No*
- *Did you find it difficult to insert variables in the MoKi?No*

Positive Experiences:
[The MOKI is very good. It is very easy to insert the relevant data and to have a good overview]

Negative Experiences:
[]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[25h]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Yes, we have hopefully a good task and domain model in the MOKI]*

Please state the main **differences** (if any) between performing this step this year and last year:
[There is a huge diference between the MOKI and the Wiki we used last year. MOKI is easier to handle, a user can model very quick due to the import function, and the browse functionalities allow a good conceptual overview over the models]

5. Step 3: Informal Models Validation and Revision

The goal of this step is to have the domain model and task model validated (completeness and correctness) by the DEs. The step was supported by guidelines, by results from automatic checks and by an on-line ontology questionnaire.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 3

Positive Experiences:
[The check report delivers a good overview, also some hints from the coaches were useful. Some relations between concepts dind't ake any sense and were detected through the formal checks and the coaches]

Negative Experiences:
[The formal check report was very long]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[16 h]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Yes, we made a few quite valuable changes in the model and eliminated conceptual mistakes]*
Please state the main **differences** (if any) between performing this step this year and last year:
[I don't remember well how we did this step last year, but the ontology check was, although it was a little bit too long quite useful]

6. Step 4: From Informal to Formal

At the end of this step, the domain model and task model will be contained in two OWL ontologies.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0

Positive Experiences:
[We didn't do anything in this step. The formalization was carried out by FBK]

Negative Experiences:
[ADD your comments here]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

7. Step 5: Modelling of Learning goals (previously known as Formal Models Integration)

The goal of this step is to obtain an OWL ontology of the learning goal model via the TACT tool.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 2

Experience with variables:

- *Did you use variables in the learning goals? Yes we did use variables, because we have a few tasks where it really makes sense to add parameters in order to not having too much learning goals and to refined the task.*
- *Did you find it difficult to understand how variables could be used in general?No.*
- *Did you find it difficult to insert variables in TACT? When you know where you have to do it (highlight respective task and topic-then it is easy. But I first did not know how to do this.*
- *If you used variables where did you find it more intuitive/easy to create tasks with variables: in the MoKi or in TACT? Both. It I very useful to have the variables created already as a hint in the TACT. But there was one task were I found out in the TACT that a variable would make sense.*

Positive Experiences:
[TACT is easy to use and especially the descriptions and the automatic generated learning goals are very useful.]

Negative Experiences:
[There is still some usability improvement]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[20h]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Yes. All tasks have now lerning goals and the specifc tasks have specific learning goals.]*

Please state the main **differences** (if any) between performing this step this year and last year:
[Having the descriptions available and automatic generated learning goals is better. The learninggoals are easier to understand and better to apply.]

8. Step 6: Formal Models Validation

At the end of this step, all the models created (domain, task and learning goals) should be formally correct and complete. The goal of this step is to have the models validated (completeness and correctness) by the DEs. The step was supported by guidelines, and by results from automatic checks similar to the one of step 3, but which also involve checking the quality of learning goals.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 2

Positive Experiences:
*[Anew the check report gives a very nice overview.
I alos liked very much the xls. Sheet that the TACT produces. With these two documents it is quite easy to check everything.]*

Negative Experiences:
[It would be nice to have everything integrated in one tool. After the final checks I found a task where I wanted to change the labeling…this can just be done by technical partners. Also I now have to update the MOKI according to the changes I did im TACT (Adding/deleting variables)…the best thing would be the have one tool, where everything is changed automatically.]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[8]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[yes]*

Please state the main **differences** (if any) between performing this step this year and last year:
[LAst year we did not have aclear overview which task has which learning goal, therefore this was better. Last year it was quite time consuming and confusing to check th formal models in Protégé]

9. General questions and remarks

- Did the domain experts coincide with the person performing the modeling? If yes, did it happen in all the steps or only some? Basically not. But some steps e.g. formal checks were done by the person performing the modeling and not by the domain expert.

- Do you think that the domain you have chosen is **appropriate** for learning support with APOSDLE? *[Yes, the domain is appropriate. The consulting area is a very knowledge intensive field – for everyone it is useful to learn from previous projects.]*

- Do you have any additional remarks or suggestions for improvement? See above ☺

Integrated Modelling Methodology
- Collection of Feedback -

The goal of this questionnaire is to collect positive and negative feedback useful for the evaluation and improvement of the Integrated Modelling Methodology.
Please state your comments the way you prefer: you can provide feedback in form of short sentences and bulleted lists as well as more complex descriptions. Both formats are perfectly acceptable.

Note for APs: Please provide feedback only for the steps you have already completed.

Partner Name: TUG (Coach of ISN)

1. Step 0: Scope & Boundaries and Resources Collection

The goal of this step is to define the scope and boundaries of the application domain to be modeled, and to gather some resources related to the application domain. The output should be a first, preliminary list of tasks (process scribble), a first list of domain concepts, and a collection of relevant learning resources.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in choosing a domain and collect the resources?*
- *Were the explanation given clear enough?*
- *Was the goal of the step completed after this step? Was there something missing?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:
3

Positive Experiences:
It was extremely helpful that all people (DE) involved knew APOSDLE P2, its functionality and possibilities. Additionally, we had created the questionnaire on APOSDLE application domains, which to me was also a very useful tool for coaching the process selecting an adequate APOSDLE domain.

Negative Experiences:
Different DE involved had different objectives with APOSDLE, defining the "learning domain" (=tasks, topics) was rather an iterative process; instead of coming up with a new model, the old one was revised.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
Approx. 40h for the creation and iterative improvement of the questionnaire, approx. 3h for the coaching (discussion with KE and DE about the domain to be used for APOSDLE P3)

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*
Yes. I think the domain was already appropriate in P2. Based on the lessons learned from P2, and based on the results from the questionnaire and the interviews with DE, a good way was found to improve the definition of the P2 domain for P3.

Please state the main **differences** (if any) between performing this step this year and last year:

1.) This year we could rely upon a "preliminary" model (P2)
2.) The questionnaire used for P2 was improved and turned out to be very helpful
3.) The people involved had an idea about how APOSDLE worked, and what could be possible

For all these reasons I think it was really easier to perform this step for P3 than for P2.

2. Step 1a: Knowledge elicitation from Digital Resources

The goal of this sub-step is to extract as much knowledge as possible from the digital resources provided by the Domain Experts. The desired output of Stage 1a is a number of candidate domain concepts.

I was not involved in this step.

3. Step 1b: Knowledge elicitation from Domain Experts (Des)

The goal of this sub-step is to elicit knowledge directly from the DEs. The desired output is a refined task list, and an extensive list of candidate domain concepts.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Did the domain experts coincide with the person performing the modeling?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*

- *Was the goal of the step completed after this step (ie., was a refined task list, and an extensive list of candidate domain concepts ready after this step)?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:
3

Positive Experiences:
We tried out several additional KE techniques (improved version of Card Sorting, Chapter Listing, Step Listing, etc.). Again, it was very advantageous to start from an existing model which needed to be improved instead starting from scratch.

Negative Experiences:
This is not exactly a negative experience but something we learned: In some cases, DE should not be involved in too similar knowledge elicitation sessions after each other (e.g. open interview about the process and the domain, and then card sorting some weeks later) – even though it might not be the case and the models might get better and more precise, the DE might have the feeling that they are giving "the same information" again and again. This means, knowledge elicitation sessions at this stage need to be carefully planned.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task: 20 hours (preparing and carrying out knowledge elicitation sessions)

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ?
Yes. Again I think that the models of P2 provided a good basis for the models of P3.

Please state the main **differences** (if any) between performing this step this year and last year:
We didn't have to start from scratch – therefore it was easier. The knowledge elicitation techniques were more mature.

4. Informal Modeling (of Domain and Tasks) in MoKi

Starting from the knowledge elicited in Step 1(a+b), the main goal of this step is to obtain an informal, but rather complete, description of the domain model and task model in a Semantic MediaWiki called MoKi. After this modeling step, the informal concept model should only consist of relevant domain concepts (see 5.2).

I was not involved in this step.

5. Step 3: Informal Models Validation and Revision

The goal of this step is to have the domain model and task model validated (completeness and correctness) by the DEs. The step was supported by guidelines, by results from automatic checks and by an on-line ontology questionnaire.

I was only involved in this step with respect to the design of the automatic checks and their interpretation. I did not help Conny (ISN-KE) in interpreting the checks and revising the models.

6. Step 4: From Informal to Formal

At the end of this step, the domain model and task model will be contained in two OWL ontologies.

I was not involved in this step.

7. Step 5: Modelling of Learning goals (previously known as Formal Models Integration)

The goal of this step is to obtain an OWL ontology of the learning goal model via the TACT tool.

Apart from writing the TACT manual and co-designing the TACT, I was not involved in this step and I didn't provide support to Conny when using it.

8. Step 6: Formal Models Validation

At the end of this step, all the models created (domain, task and learning goals) should be formally correct and complete. The goal of this step is to have the models validated (completeness and correctness) by the DEs. The step was supported by guidelines, and by results from automatic checks similar to the one of step 3, but which also involve checking the quality of learning goals.

I was only involved in this step with respect to the design of the automatic checks and their interpretation. I did not help Conny (ISN-KE) in interpreting the checks and revising the models.

9. General questions and remarks

- Did the domain experts coincide with the person performing the modeling? If yes, did it happen in all the steps or only some?

No, the person who was modeling was Conny, domain experts were other people in all steps. Nonetheless, Conny is working at ISN for some time now and has some knowledge about the domain.

- Do you think that the domain you have chosen is **appropriate** for learning support with APOSDLE? *[Please give reasons for your answer]*

Yes – see step "Scope and Boundaries".
[I think the domain was already appropriate in P2. Based on the lessons learned from P2, and based on the results from the questionnaire and the interviews with DE, a good way was found to improve the definition of the P2 domain for P3.]

- Do you have any additional remarks or suggestions for improvement?

I think 1 variable in the task is a useful means to reduce modeling efforts. However, we have learned (e.g. from the final number of tasks in the ISN model) that using variables leads to a huge number of tasks very easily. This has to be taken into account for coaching.

Integrated Modelling Methodology
- Collection of Feedback -

The goal of this questionnaire is to collect positive and negative feedback useful for the evaluation and improvement of the Integrated Modelling Methodology.
Please state your comments the way you prefer: you can provide feedback in form of short sentences and bulleted lists as well as more complex descriptions. Both formats are perfectly acceptable.

Note for APs: Please provide feedback only for the steps you have already completed.

Partner Name: SAP (Coach of CNM and CCI)

1. Step 0: Scope & Boundaries and Resources Collection

The goal of this step is to define the scope and boundaries of the application domain to be modeled, and to gather some resources related to the application domain. The output should be a first, preliminary list of tasks (process scribble), a first list of domain concepts, and a collection of relevant learning resources.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in choosing a domain and collect the resources?*
- *Were the explanation given clear enough?*
- *Was the goal of the step completed after this step? Was there something missing?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: CCI 0, CNM 3

Positive Experiences:
[ADD your comments here]

Negative Experiences:
[ADD your comments here]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ?
In our opinion the goals were fulfilled. We had a tasks model which was concerted with the CCI's workflow and a great collection of relevant learning resources. For CNM we had a domain model and a deeper understanding about the domain. For Rescue, there was no effort in this stage since the models already existed.

Please state the main **differences** (if any) between performing this step this year and last year:
Application Partners were much more experienced/did work more independently. The iterative process using graphical tools from the beginning turned out to be much easier. The discussions with CNM helped to focus very early in the process and reduced effort. Main Work was done by application partners. Main effort for SAP in this stage was to get an overview/understanding of the CNM iTel process.

2. Step 1a: Knowledge elicitation from Digital Resources

The goal of this sub-step is to extract as much knowledge as possible from the digital resources provided by the Domain Experts. The desired output of Stage 1a is a number of candidate domain concepts.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Was the knowledge elicited useful?*
- *What where the main difficulties encountered in eliciting knowledge from resources?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step? Was there something missing?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0 CCI, 3 CNM

Positive Experiences:
With CNM, we had a meeting to sort/extract the main knowledge about ITel. Using Card sorting in several rounds, we lead CNM to get an overview and structure the domain and contenets themselves.

Negative Experiences:
We had to travel to Dortmund. This step took a lot of time, but was important to structure and facilitate the proceeding steps.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *Both for CNM and CCI we had a good overview and a structure of a domain after this step.*

Please state the main **differences** (if any) between performing this step this year and last year:
Card Sorting with CNM to structure from the beginning.

3. Step 1b: Knowledge elicitation from Domain Experts (Des)

The goal of this sub-step is to elicit knowledge directly from the DEs. The desired output is a refined task list, and an extensive list of candidate domain concepts.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Did the domain experts coincide with the person performing the modeling?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step (ie., was a refined task list, and an extensive list of candidate domain concepts ready after this step)?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0 CCI, 3 CNM

Positive Experiences:

[CCI: everything was done by CCI, not very much coaching effort. CNM: Review of an ITel document. Main effort was in this Stepp to get a deeper understanding of the new field at CNM. Therefore we transformed the Card Sorting
Result into a hierarchy by understanding the sorting piles from the different dorting rounds as attributes. We wonder if there is room for a further formalisation of this hierarchy-creating step, e.g. by applying Formal Concept analysis.

Negative Experiences:
Further formal guidance for transforming card sorting into a hierarchy would be helpful.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *Both CNM and CCI had a good basis for the proceeding steps in this stage.*

Please state the main **differences** (if any) between performing this step this year and last year:
CCI reduced the effort to one domain model. CNM was extended to Rescue and iTEl. The effort for Rescue in those stages was still very low since it just had to be transferred into P3.

4. Informal Modeling (of Domain and Tasks) in MoKi

Starting from the knowledge elicited in Step 1(a+b), the main goal of this step is to obtain an informal, but rather complete, description of the domain model and task model in a Semantic MediaWiki called MoKi. After this modeling step, the informal concept model should only consist of relevant domain concepts (see 5.2).

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Was the wiki used in a collaborative manner?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0 CCI, 0 CNM

Experience with variables:

- *Did you use variables in the informal model? Please indicate why or why not.*
- *Did you find it difficult to understand how variables could be used in general?*
- *Did you find it difficult to insert variables in the MoKi?*

Positive Experiences:
Using the Sematic MediaWiki was very easy this time. Changing content was more intuitive, the overall process was much faster. The task model was much easier, just the numbers had to be added. There were less tools, especially not using YAWL did save a lot of time for us. Neither for CNM nor for CCI variables were required.

Negative Experiences:
[We had to do the Rescue Modeling for CNM. We also added the iTel model into the MoKi. There was just a check done by CNM .

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ?
The models after this step very already in a almost final form. This was a result of the intuitive MoKi.

Please state the main **differences** (if any) between performing this step this year and last year:
MoKi Much easier to use, less tools. More experience.

5. Step 3: Informal Models Validation and Revision

The goal of this step is to have the domain model and task model validated (completeness and correctness) by the DEs. The step was supported by guidelines, by results from automatic checks and by an on-line ontology questionnaire.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*

- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0 for CNM and CCI

Positive Experiences:
The tools were adequate for the models. Since the models were kept simple, the modeling process in general was much easier. There were just minor changes in this step.

Negative Experiences:
Change all CCI is-part-of-relations into is-a-relationsI. This step did not produce much effort, we still don't understand why relations are provided at the beginning and have to be changed at the end because of technical reasons.Furthermore, the current model does not exactly express what CCI did want to model. We mainly had to do the Rescue Modeling for CNM

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[*
There were just minor changes in later steps. The check made us sure to have completed the informal model before going into the formal modeling phase.
Please state the main **differences** (if any) between performing this step this year and last year:
The MoKi's usability was much better then in the previous year. Therefore, the models were in a good shape from the beginning.

6. Step 4: From Informal to Formal

At the end of this step, the domain model and task model will be contained in two OWL ontologies.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*

- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you:
0

Positive Experiences:
The OWL was a result of automatic exports. There were no problems and no effort.

Negative Experiences:

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*
Has to be evaluated by application partners.

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

7. Step 5: Modelling of Learning goals (previously known as Formal Models Integration)

The goal of this step is to obtain an OWL ontology of the learning goal model via the TACT tool.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0 CCI, 2 CNM

Experience with variables:

- *Did you use variables in the learning goals? Please indicate why or why not.*
- *Did you find it difficult to understand how variables could be used in general?*
- *Did you find it difficult to insert variables in TACT?*
- *If you used variables where did you find it more intuitive/easy to create tasks with variables: in the MoKi or in TACT?*

Positive Experiences:
Using the TACT tool was not difficult. The manual was very useful to understand the meaning of learning goal types and how to use the tool.

Negative Experiences:
We had to do the Rescue Modeling for CNM. The old models had to be transferred to the new version. This step was much effort for SAP.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[*
The results look good, there are still some checks to perform for CNM.

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

8. Step 6: Formal Models Validation

At the end of this step, all the models created (domain, task and learning goals) should be formally correct and complete. The goal of this step is to have the models validated (completeness and correctness) by the DEs. The step was supported by guidelines, and by results from automatic checks similar to the one of step 3, but which also involve checking the quality of learning goals.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0

Positive Experiences:
The results of automatic checks helped to reduce the effort. They provided a good feedback what points still have to be closer checked.

Negative Experiences:
The whole process can only be performed by knowledge engineers and not by domain experts.

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*

Please state the main **differences** (if any) between performing this step this year and last year:
[ADD your comments here]

9. General questions and remarks

Did the domain experts coincide with the person performing the modeling? If yes, did it happen in all the steps or only some?
For CCI we had different persons. For CNM, the domain expert also performed the modeling.

- Do you think that the domain you have chosen is **appropriate** for learning support with APOSDLE? *[Please give reasons for your answer] has to be evaluated by applications partners.*

- Do you have any additional remarks or suggestions for improvement? The coaching effort is still high. It would even be much higher if the application partners would not be as experienced. Without a knowledge engineer, the modeling process would not be possible. Domain experts themselves cannot finish the modeling on their own. But in addition, our overall impression is, that the amount of time to be invested is acceptable. All in all, we can imagine the opportunity for an "APOSDLE company" (i.e. exploitation strategy) to sell modeling as a service, which can be peformed (and sold!) supported by the IIM in due time and quite independently from the domain to be modeled, i.e. from our experience of coaching/developing *several* models with *several* partners we perceive the IIM as domain-independent enough "to be sold".

Integrated Modelling Methodology
- Collection of Feedback -

The goal of this questionnaire is to collect positive and negative feedback useful for the evaluation and improvement of the Integrated Modelling Methodology.
Please state your comments the way you prefer: you can provide feedback in form of short sentences and bulleted lists as well as more complex descriptions. Both formats are perfectly acceptable.

Note for APs: Please provide feedback only for the steps you have already completed.

Partner Name: FBK (Coach of EADS)

1. *Step 0: Scope & Boundaries and Resources Collection*

The goal of this step is to define the scope and boundaries of the application domain to be modeled, and to gather some resources related to the application domain. The output should be a first, preliminary list of tasks (process scribble), a first list of domain concepts, and a collection of relevant learning resources.

Not involved

2. *Step 1a: Knowledge elicitation from Digital Resources*

The goal of this sub-step is to extract as much knowledge as possible from the digital resources provided by the Domain Experts. The desired output of Stage 1a is a number of candidate domain concepts.

Not involved

3. *Step 1b: Knowledge elicitation from Domain Experts (Des)*

The goal of this sub-step is to elicit knowledge directly from the DEs. The desired output is a refined task list, and an extensive list of candidate domain concepts.

Not involved

4. Informal Modeling (of Domain and Tasks) in MoKi

Starting from the knowledge elicited in Step 1(a+b), the main goal of this step is to obtain an informal, but rather complete, description of the domain model and task model in a Semantic MediaWiki called MoKi. After this modeling step, the informal concept model should only consist of relevant domain concepts (see 5.2).

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *Was the wiki used in a collaborative manner?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 1

Experience with variables:

- *Did you use variables in the informal model? Please indicate why or why not.*
- *Did you find it difficult to understand how variables could be used in general?*
- *Did you find it difficult to insert variables in the MoKi?*

I was not deeply involved in coaching EADS during the conceptual analysis for adding variables to tasks. From the technical point of view, it was easy to add variables to tasks, thanks also to the auto-completion functionality in the MoKi.

Positive Experiences:
The objectives where clear. The tool chosen is adequate for this step of the methodology, especially if domain experts are active involved in the modeling phase. The tool has greatly improved wrt last year's one. The MoKi has been used in a collaborative manner, since coaches were able to monitor and provide feedback on the work of application partners.

Negative Experiences:
[ADD your comments here]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
[ADD your comments here]
3 hours

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ?
Yes, as the AP has been able to produce quite detailed domain and task models.

Please state the main **differences** (if any) between performing this step this year and last year:

The tool has greatly improved (new templates, forms vs wiki-syntax editing, new visualization functionalities, delete/rename support), wrt last year's one, thus easing the work of people involved in modelling activities.

5. Step 3: Informal Models Validation and Revision

The goal of this step is to have the domain model and task model validated (completeness and correctness) by the DEs. The step was supported by guidelines, by results from automatic checks and by an on-line ontology questionnaire.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 1

Positive Experiences:
The objectives where clear, as well as the explanation.
The automatic checks turn out to be very useful to fulfill the objectives.
Also the visualization functionalities in the MoKi helped a lot in this phase

Negative Experiences:
[ADD your comments here]

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task:
1-2 hours

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ?
Yes

Please state the main **differences** (if any) between performing this step this year and last year:
last year, there were no automatic checks at this stage. Furthermore, there were no visualization functionalities in the MoKi to help revising the models.

6. Step 4: From Informal to Formal

At the end of this step, the domain model and task model will be contained in two OWL ontologies.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 0

Positive Experiences:
This phase has been performed in a full automatic way thanks to the MoKi built-in export functionalities, without any effort from application partner and coaches

Negative Experiences:

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task: *0*

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner ? *[Please give reasons for your answer]*
Yes, the model developed into the MoKi has been translated into valid formal models.

Please state the main **differences** (if any) between performing this step this year and last year:

7. Step 5: Modelling of Learning goals (previously known as Formal Models Integration)

The goal of this step is to obtain an OWL ontology of the learning goal model via the TACT tool.

Not involved

8. Step 6: Formal Models Validation

At the end of this step, all the models created (domain, task and learning goals) should be formally correct and complete. The goal of this step is to have the models validated (completeness and correctness) by the DEs. The step was supported by guidelines, and by results from automatic checks similar to the one of step 3, but which also involve checking the quality of learning goals.

Feedback:

Please state positive and negative experiences of the IMM for this step in the space below. Use as much space as you need.
Some questions to keep in mind while providing the feedback:

- *Were the objectives clear?*
- *Were the tools adequate?*
- *What where the main difficulties encountered in this stage?*
- *Were the explanations given clear enough?*
- *Was the goal of the step completed after this step?*

Please **rate** (form 0 to 5, where 0 is very easy and 5 is extremely difficult) **how difficult** this step was for you: 1

Positive Experiences:
The objectives where clear, as well as the explanation.
The automatic formal models checks turn out to be very useful to fulfill the objectives.

Negative Experiences:

Please **estimate your modeling (coaching) efforts** at this stage in terms of hours spent to perform the task: 1

Do you think that the outcome produced in this step **fulfilled the goals** of the step in a satisfiable manner?
Yes

Please state the main **differences** (if any) between performing this step this year and last year:
No revision of the models has been necessary at this stage this year, probably due to the higher quality models developed during the informal model phase.

9. General questions and remarks

- Did the domain experts coincide with the person performing the modeling? If yes, did it happen in all the steps or only some?

The real modelling activities have been performed only by Knowledge Engineers.

- Do you think that the domain you have chosen is **appropriate** for learning support with APOSDLE?

I can't really say much about this at this point. However, I have the feeling that the domain chosen is somehow too general.

- Do you have any additional remarks or suggestions for improvement?